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DEBRIS BARRIER NO. 1, YUBA RIVER, CAL.

A self-built hydraulic fill dam, aided and anchored by rock-fill, piling and concrete facing, is under construction on the Yuba River, near Marysville, Cal. The work is being carried out by the California Debris Commission, as a part of a comprehensive scheme which is outlined by the Commission as follows:

Briefly stated, the Yuba River project provides for holding and storing the enormous quantities of mining debris now in that stream and its tributaries by means of works between Smartsville and Marysville designed to separate the coarse material from the fine, holding and storing both kinds as they are brought down the river from above, and, also, to confine the low-water channel in the lower reaches within narrower limits in order to hold in place the extensive deposits already there. These results are sought to be accomplished by means of four restraining barriers in the bed of the river and by a settling basin adjoining the river on the south, the structures to be provided with necessary weirs and conduits to regulate the flow of water. The two barriers in the upper part are designed to hold the coarser material and the settling basin to cause the finer material carried in suspension to be deposited.*

The structure now being built is known as Barrier No. 1. It is located at the foot of the steeper part of the river slope, where the velocity of the river is high, and where the saturated river bed is very unstable. The settling basin mentioned in the above quotation will be three or four miles below Barrier No. 1. It will be enclosed by a dike and water will be diverted to it by a low dam. It is expected that silt will be deposited in the basin to a depth of 8 or 9 ft., amounting to about 14,000,000 cu. yds. in all. Opposite the settling basin a flood-overflow channel is being cut through a promontory called Daguerre Point. This channel will be some 1,000 ft. long and will have a maximum depth of about 32 ft., an average depth of some 25 ft., a bottom width ranging from 650 to 870 ft., and side slopes varying from 1 to 1 to 1 to 2. About 750,000 cu. yds. of earth will be removed. The contractor for the cut began work on Dec. 10, 1903. In times of flood the settling basin will be cut out and the flow passed down the cut and back into the river. Below the cut training walls about two miles long, high enough to prevent overflows, are proposed. Eventually these walls may be extended to the Feather River, or training walls at a lesser height built in the lower sections. Some of the dikes to form the settling basin are now being built free of charge by gold dredgers that are thus getting rid of their waste material. The settling basin is about ten miles above the Junction of the Yuba and Feather Rivers, at Marysville, Cal. The Feather River is a tributary of the Sacramento.

Before proceeding with a description of Barrier No. 1, a few words may be said regarding the California Debris Commission and its previous efforts to build barriers across the Yuba. The Commission was created by an act of Congress, approved March 1, 1893, which provides that it shall consist of three officers of the Corps of Engineers. Its duties are the regulation and encouragement of hydraulic mining in the drainage areas of the Sacramento and San Joaquin Rivers and the improvement and protection of the navigability of the rivers named. For a number of years the work of the Commission appears to have been confined almost wholly to licensing and regulating placer mining. In 1900 an estimate of the cost of treating the Yuba River was published, and in 1902 this work was authorized by Congress, which appropriated $400,000, with the provision that the State of California should supply a like amount. The expenses of the work are therefore being divided equally between the state and the national governments.

During 1902 and 1903 construction was begun on Barriers Nos. 1 and 2. The plans then adopted proved the possibility of making the stream build the barriers out of the debris, but also proved the futility of (1) gravel and brush protected by rock, and (2) rock-filled fascine cribwork as barriers for impounding the debris.*

In 1904 the scheme shown by the accompanying details was put under contract, and the first of the six steps was completed in October of that year. During the fall and winter the space behind the step was filled with debris. A second step 8 ft. higher is now under construction. The accompanying view shows 4 ft. of water passing over the first step of the barrier.

The details shown by the illustration are so complete that little further regarding the design need be said. The first step is about 1,250 ft. long. Sand and gravel to fill the spaces between the rock-fill were sluiced in. The original intention was to drive sheet-piling just above the down-stream row of piles, but owing to the difficulties encountered this was given up, the piles were driven 3 ft. c. to c., instead of 6 ft., and the planking shown was secured to the piles. There having been more scour than was expected, the rock apron below the barrier will be extended.

A special feature of the barrier is the making of the concrete facing on the down-stream side in detached blocks, but joined together by the cables. The object of this is to permit sections of the facing to drop down in case any of the material is washed from beneath them, thus continuing the protection to the rock-fill. Any cavities thus formed would be properly filled at the next period of low water.

It will be noticed that the piles are only anchor piles, the concrete facing of the dam not being supported by them except he narrow strip between the large blocks. The piling and bulkheads also stiffen the work, and prevent sliding on the unstable base.

The piling work for the first step was done by the United States, 850 piles being used. The piles cost 27½ cts. per lin. ft., or $11 per pile delivered at the site of the work, and the driving cost $5.02 each. Penetration in the gravel was from 30 to 40 ft., and was secured by hard driving, efforts to sink them by the hydraulic jet proving failures, due to the quantities of cobbles encountered.

The first step cost nearly $58,000 by contract, in addition to the piling, or about $46 per lin. ft., and, including piles, about $58 per ft.

Work on the second step has been contracted for at a total cost of $41,720, or about $37 per lin. ft. The remaining steps in the future should not cost more than the second step, the apron making the cost of the first step considerably higher.

Eventually a spillway will be built, and through it the highest floods will be diverted, thus reducing the maximum height over the barrier from a probable 7 ft. to only 4 or 5 ft.

We are indebted to Wm. W. Harts, Captain, Corps of Engineers, U. S. Army, and Secretary

A 4-FT. FLOOD GOING OVER THE FIRST STEP OF BARRIER NO. 1, YUBA RIVER, CAL.

*From Annual Report of the California Debris Commission for the Fiscal Year Ending June 30, 1904; being Appendix Z Z of the Annual Report of the Chief of Engineers for 1904. D. P. Heap, Colonel, Corps of Engineers, U. S. A. (to Sept. 10, 1903); W. H. Heuer, Colonel, Corps of Engineers, U. S. A.; Thos. H. Handbury, Lieut.-Col., Corps of Engineers, U. S. A. (since Sept. 10, 1903); Wm. W. Harts, Captain, Corps of Engineers, U. S. A. (since Sept. 19, 1903); R. P. Johnston, Captain, Corps of Engineers, U. S. A. (to Sept. 19, 1903), Commissioners.

*The experiences with these types of construction are given in the report cited in the previous foot note.

of the California Debris Commission,* for the photograph and blueprints here reproduced, and for information given to a member of the editorial staff of this journal.

THE UNITED STATES RECLAMATION SERVICE.

By F. H. Newell,† M. Am. Soc. C. E.

The seventeenth of June, 1905, marks the third anniversary of the passage of the Reclamation Act, one of the most notable steps taken by Congress in recent years. This Act sets aside the

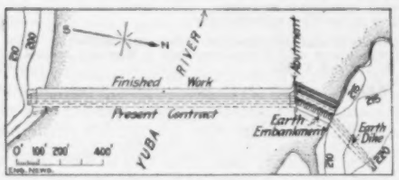


Fig. 1. General Plan of Debris Barrier No. 1, Yuba River, Cal.

proceeds from the disposal of public lands in 13 Western States and 3 Territories. There is now available under this Act the sum of, in round numbers, $30,000,000, and plans have been matured for expending practically this entire amount in the construction of National works for the reclamation of arid lands.

One of the matters of chief interest to engineers and business men is the organization of the engineering corps or body of men known as the Reclamation Service, created for the purpose of putting the law into effect. It is the outgrowth of or development from a small group of hydraulic engineers brought together in 1888 by the late Major J. W. Powell, Director of the U. S. Geological Survey, and known originally as the Hydrographic Division of the Geological Survey. The investigations or first irrigation survey begun under Major Powell into the extent to which the arid lands might be reclaimed was continued and strengthened under his successor, Charles D. Walcott, the present Director of the Survey.

Without entering into a discussion of the history which led up to the passage of the Reclamation Act, it is sufficient to state that on the passage of this Act the hydraulic engineers connected with the Geological Survey were taken by the Secretary of the Interior to form the nucleus of the Reclamation Service. From time to time other engineers were added to the corps until from a dozen or more men the Reclamation Service has in three years grown to an organization of upward of 360 engineers, assistants and engineering aids.

These men have been carefully selected as a result of competitive Civil Service examinations. The markings on these examinations have, as a rule, been severe, but of those who have passed the examinations the majority have been appointed and given permanent positions, where, as ability is demonstrated, advancement may be looked for. In Engineering News for Nov. 26, 1903, there was a discussion of the salaries paid these men on entering the service. Promotion has been relatively rapid, so that the present condition is as follows:

Class.	Annual salary.	Number.
B & C	$720 or more	30
D	$900 or more	70
E	$1,000 or more	30
1	$1,200 or more	60
2	$1,400 or more	40
3	$1,600 or more	35
4	$1,800 or more	30
5	$2,000 or more	35
6	$2,500 or more	30
	Total	360

Surveys, examination and construction under the terms of the Reclamation Act are being carried on in widely separated localities and at points remote from lines of travel. The difficulties of organization have, therefore, been greatly increased over what they would have been had the work been concentrated at one point, or within a relatively small area, as in the case of the Panama Canal. Men capable of exercising a large amount of discretion regarding important details of expenditure and of judgment as to the character of work must be sent out in charge of relatively small parties. To meet this condition the work in each State or large drainage basin has been put in charge of a district engineer, who, to a large extent, initiates and controls the operations and expenditures. He reports to a supervising engineer, who is practically the representative of the Chief Engineer, and who with the district engineer determines many matters which can not be referred to the Washington office. There are eight supervising engineers, each of whom has cognizance of the work in several States.

The supervising and district engineers must give much of their time to purely executive matters. It has been found necessary, therefore, to supplement their work by consulting engineers, who, being freed from business detail, can consider with least disturbance the technical engineering matters. With these consulting engineers are grouped also certain experts in mechanical, electrical and related matters, whose advice is essential in the determination of the final plans. The consulting and supervising engineers spend their time at various projects or with the district engineers and with field parties, thus becoming thoroughly familiar with the various local conditions.

Whenever the plans and estimates have reached a point where the district engineer desires formal action upon them the papers are transmitted to the Chief Engineer at the Washington office and are by him referred to a board consisting of one or more consulting engineers, the supervising engineer and the district engineer, together with one or more experts or specialists. This board, convened at a given time and place, consists of men who are already familiar with the project from various standpoints. The report in hand is taken up, gone over very carefully, and a written recommendation prepared and signed by all of the members present. It occasionally happens that the board decides that the data acquired are not sufficient for final action, and refers the matter back for further details; or, if there is a difference of opinion, frequently the board as a whole goes into some particular investigation. Ultimately a concise report is produced, meeting the unanimous approval of all members.

Boards are also convened to open bids received from contractors and to recommend the award to be made. Each consecutive board is constituted of different members and of men best qualified to pass upon the point at issue; thus the individual members of the various boards by meeting and reorganizing at short intervals exchange views and keep in touch with a large number of projects.

The executive head of the Reclamation Service must of necessity be at the city of Washington and in close touch with the Secretary of the Interior, who is the official named by law to carry out the purpose of the Reclamation Act. All reports come to the Chief Engineer and all papers are approved by him, being transmitted finally by the Director of the Geological Survey to the Secretary of the Interior. As it is necessary for the Chief Engineer to be continually in the Washington office to expedite business, and at the same time he should be in the field, it results that practically two persons at least must fill this position, one acting while the other is absent in the field. There is thus an alternation in duties between the Chief Engineer and A[illegible] Chief Engineer by which one or the other [illegible] y in Washington.

The results of preliminary survey[illegible]ked up in the local offices and the desig[illegible]ruc-tures is done as nearly as possible [illegible]lity itself, so that the men engaged on [illegible]icu-lar piece of work have before them [illegible]deal conditions and limitations. Temporary [illegible] are erected to accommodate the field men, [illegible]eory being that better results are obtain[illegible] the ground than in a central office. An ex[illegible]n to this is in the case of extreme climatic c[illegible]ions, such as those in the North, where it is [illegible]d to be more economical to bring the men [illegible] the winter to Salt Lake or Denver, where [illegible] can be in contact with other engineers w[illegible]g on similar problems.

The principal works now under [illegible]truc-tion, or to be begun at an early date, are as follows:

ARIZONA.—Roosevelt Dam. Contract [illegible]arded early in 1905 to John M. O'Rourke & C[illegible] Galveston, Tex. Estimated cost, about $1,[illegible]000. Power canal, constructed by Robert Sherer & Co., Los Angeles, Cal., and portions by John Tuttle, San Francisco, Cal., and is now nearly completed.

CALIFORNIA.—Laguna Dam. Bids were to be opened June 5, 1905. Estimated cost, about $1,000,000.

COLORADO. — Gunnison Tunnel. Contract awarded in December, 1904, to the Taylor-Moore Construction Co., of Hillsboro, Tex. Length, 30,000 ft.; estimated cost, something over $1,000,000. Canal contracts have also been executed with Knowlton & Boilen Construction Co., Ft. Collins, Colo., for Secs. 1, 2, 7, 8 and 9, south canal; with Orman & Crook, Pueblo, Colo., for Secs. 3, 4 and 5, south canal; and with Kellogg & Worley, Gunnison, Colo., for Sec. 6, of south canal.

IDAHO.—Minidoka Dam. Contract executed with Bates & Rogers Construction Co., Chicago, Ill. Length of dam, 675 ft.; cost, approximately $500,000. Work was begun in November, 1904.

MONTANA.—The bids for the main canal near Glendive, Mont., were to be opened on June 1, 1905; also bids for the canal near Huntley are to be opened on June 28, 1905.

NEBRASKA.—The Interstate Canal bids were opened at Denver, on May 16. For this canal water will be obtained from the Pathfinder Dam in Wyoming, the contract for the tunnel of which has been awarded to the Kilpatrick Bros. & Collins Contracting Co., Beatrice, Neb.

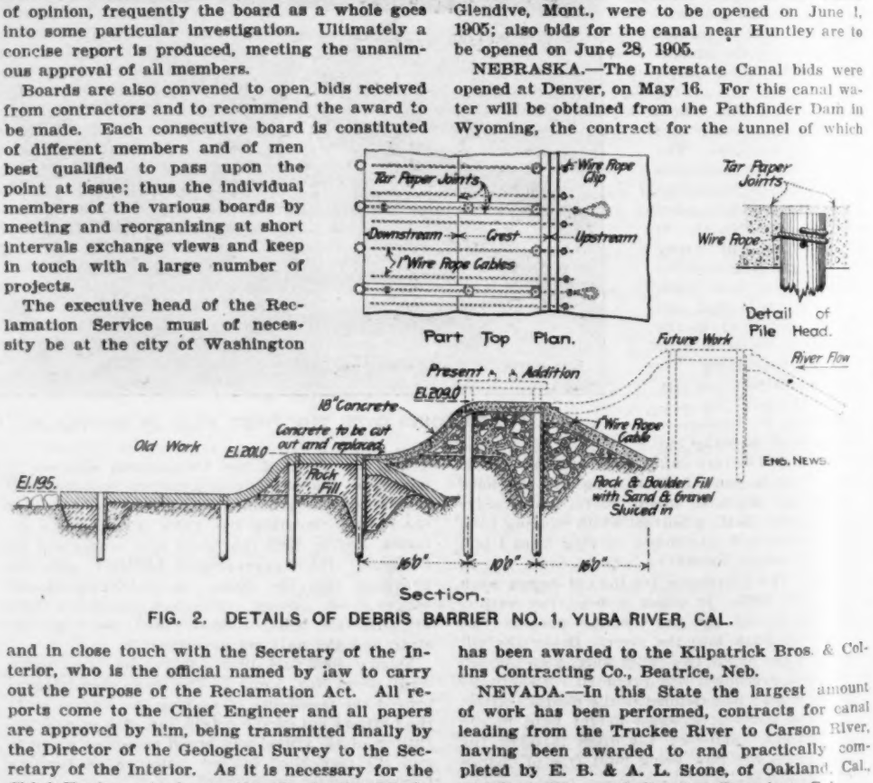


FIG. 2. DETAILS OF DEBRIS BARRIER NO. 1, YUBA RIVER, CAL.

NEVADA.—In this State the largest amount of work has been performed, contracts for canal leading from the Truckee River to Carson River, having been awarded to and practically completed by E. B. & A. L. Stone, of Oakland, Cal., and C. A. Warren & Co., San Francisco, Cal.

Other contracts have been executed for additional construction by the Pacific Coast Construction Co., Portland, Ore., San Francisco Construction Co., San Francisco, Cal., R. C. Mattingly, San Francisco, and Utah Construction Co., of Ogden,

*Flood Building, San Francisco, Cal.
†Chief Engineer, U. S. Reclamation Service, Washington, D. C.

These are for portions of the distributing from Carson River.

were to be opened on June 15 for the ng works at the outlet of Lake Tahoe at of Truckee River.

W MEXICO.—The Hondo Dam and canals been nearly completed under contracts d to the Slinkard Construction Co., of Ros- N. M., and the Taylor-Moore Construction Hillsboro, Texas.

TH DAKOTA.—The Fort Buford Canal t was awarded from bids opened June 5,

TH DAKOTA.—The Belle Fourche Canal built under contracts let in May, 1905, to H. Robinson, St. Louis, Mo., and The Widell- Co., of Mankato, Minn.

YOMING.—Bids will be advertised at an date for work in connection with the ge works and canal on the Shoshone River.

In the states not mentioned above active operations have been carried on and every effort is being made toward early construction. There have been, as was expected, many engineering difficulties; but the largest source of delay has been in acquiring necessary rights or titles. The Government in its acquisition of property is required by law to be extremely cautious and can not assume risks, as in the case of individuals. The preliminary matters leading up to the purchase are examined by suitable legal experts connected with the Reclamation Service, several of these being men who have had engineering education and experience and have later taken up the study of law and been admitted to the bar. This training has been invaluable in adding to their effectiveness in this particular line of work.

The duties of the Reclamation Service are not merely those of surveying and construction, but enter into all matters of policy in dealing with individuals and communities. It is necessary not merely to build great hydraulic works for storing and distributing water; but more than this, the land must be subdivided into tracts or farm units capable of sustaining a family and the people must be organized, so that the works may be paid for by the canal owners in ten annual instalments. When thus paid for they are turned over to the operation and control of the community. This necessitates dealing with a large number of individuals and the gradual creation of a system which is in many respects similar to the municipal ownership of public utilities.

Moreover, not only must there be a tactful dealing with people, but consideration must be given to the capabilities of the soil and to the dangers of its becoming reduced in value by seepage or percolation of waters and by the development of alkali. These matters of alkali and of drainage are studied with other engineering features and experts are designated to give their entire time and attention to the laying out of the irrigation system, with its related drainage works, to prevent future disaster.

In brief, it may be said that in the space of three years an organization has been devised and put in successful operation to cope with the engineering and physical difficulties and to deal with people and problems scattered throughout the western half of the United States. The future development and prosperity of many communities is dependent upon the wise conduct of this work, for the creation of thousands of homes in the arid and semi-arid parts of the United States means not merely the prosperity of these localities, but the stimulation of all industries throughout the country. The farmers on irrigated lands are, when firmly established, the largest producers on limited areas. They practice the most intensive cultivation, raising two, three or more crops each year. These communities of f best home markets and the transporta- and manufacturing interests of the country find in them their strongest support.

It is therefore not to be wondered at that President Roosevelt, with his broad knowledge of the whole country, has given much personal thought to irrigation and has put the strength of his personality behind the passage of the law and into its successful execution. The actual operations are in the hands of Secretary Hitchcock, and he in turn has delegated the details to Director Walcott. Too much can not be said in praise of the latter's executive ability and the sound judgment in handling the many problems presented to him. Mr. Walcott while not a professional engineer has built and brought to successful termination many large enterprises, and has rendered most effective services to the Government of over a quarter of a century. All of this has been done in addition to his scientific investigations and conduct of a great bureau.

A NOTABLE REDUCTION OF TYPHOID FEVER IN CHICAGO, 1881 TO 1904,* INCLUSIVE.

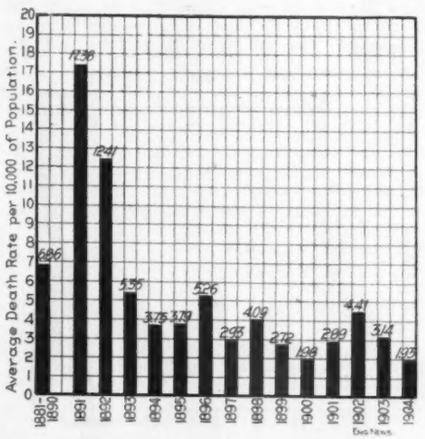
Chicago's finally successful fight against typhoid fever covers a period of less than a dozen years.

In 1891 it had the highest typhoid death rate of any large city in the world—17.38 per 10,000 of its population.

In 1905 its typhoid rate is among the lowest—1.21 per 10,000 for the 147 elapsed days of the year, and a reduction of more than 93% from the rate of 1891.

The 1891 rate had a single obvious cause—a sanitary blunder. The 1905 rate is the result of persistent, intelligent sanitary effort.

Typhoid fever began to increase materially with an increase in the number of lake-emptying sewers. At the close of 1888 there were but three sewers discharging into the lake—those at Twelfth, Twenty-second and Thirty-first streets. Subsequently these were increased to 11 south of the main river and to 18 north of Fullerton Ave.



Reduction of Typhoid Fever in Chicago Death Rates per 10,000 Population, 1881 to 1904, Inclusive.

At the time when this monstrous sanitary crime was committed the city's water supply was taken from the lake at distances varying from 1,400 ft. to two miles from shore. With the increase sewage in the shore water typhoid increased, so that the 375 and the 453 typhoid deaths of 1888 and 1889, respectively, were swollen to 1,008 in 1890, to 1,997 in 1891, and to 1,849 in 1892.

The success of the World's Fair was threatened. Chicago was advertised to the uttermost ends of the earth as a plague-stricken city, to be shunned by all who valued health and life. Herculean efforts were made to remedy the conditions; tunnels were extended; shore intakes were abandoned; the completion of the Four-mile tunnel was hastened, and the sewage-pumping works at Bridgeport were pushed to the limit.

As a result the total typhoid deaths during 1893, the World's Fair year, fell from a yearly average of 1,498, immediately following the multiplication of the lake-emptying sewers, to 670—a decrease of more than one-half (55%).

Since that time there have been further tunnel extentions and a new two-and-a-half-mile tunnel—the Carter H. Harrison—has been constructed, so that at present all intakes are beyond the zone of sewage pollution under usual conditions.

Supplementing this work, in order of priority, came the diversion of the Twelfth St. and the Twenty-second St. sewers from the lake to the South branch—recommended to the Mayor in a communication from the Department, dated Oct. 9, 1897. This diversion was completed in the autumn of 1898 and was followed in 1899 by a 60% improvement in the sanitary quality of the Four-mile tunnel supply—the supply chiefly affected by the discharge of these sewers.

Next, the August, 1899, Bulletin announced that "After three years' effort the Department has succeeded in prohibiting the deposit of river and harbor dredgings in Lake Michigan within eight miles of the shore line—except within the inclosed space known as the Lake Front Basin." This prohibition was secured only after repeated demonstrations of pollution of the Four-mile tunnel supply by these deposits, even after the sewers' diversion.

At midnight Jan. 17-18, 1900, the Drainage Channel of the Sanitary District was put in operation, and during the last year the South Side intercepting-sewer system was concluded from the lake south of Fullerton Ave.

The appended diagram and table are from the forthcoming report of the Department for the year 1904. Together with the foregoing summary, from the same source, they are commended to the study of the author of a recent magazine article on typhoid fever in Chicago, every line of which betrays the fine enthusiasm of youth and the courage of its ignorance.

*From the Bulletin of the Health Department of Chicago for the week ending May 27, 1905; Arthur R. Reynolds, M. D., Commissioner of Health.

TYPHOID FEVER MORTALITY IN CHICAGO, 1881-1904, INCLUSIVE.

Years	Population Estimated for the intercensal years by U. S. Census Office.*	Deaths from typhoid fever.	Death rates per 10,000 of Population.	Ratio per cent. of typhoid to total deaths, all causes.
1881.....	540,000	568	10.51	4.09
1882.....	560,693	462	8.25	3.49
1883.....	580,000	361	6.22	3.12
1884.....	629,885	354	5.61	2.84
1885.....	665,000	496	7.45	3.98
1886.....	703,715	483	6.86	3.53
1887.....	760,000	382	5.02	2.48
1888.....	802,651	375	4.67	2.35
1889.....	935,000	453	4.84	2.67
1890.....	1,099,850	1,008	9.17	4.60
1891.....	1,148,795	1,997	17.38	7.20
1892.....	1,199,730	1,489	12.41	5.67
1893.....	1,253,022	670	5.35	2.47
1894.....	1,308,682	491	3.75	2.05
1895.....	1,366,813	518	3.79	2.14
1896.....	1,427,527	751	5.26	3.24
1897.....	1,490,937	437	2.93	2.00
1898.....	1,557,164	636	4.09	2.70
1899.....	1,626,333	442	2.72	1.73
1900.....	1,698,575	337	1.98	1.34
1901.....	1,757,010	509	2.89	2.09
1902.....	1,815,445	801	4.41	3.63
1903.....	1,873,880	585	3.14	2.07
1904.....	1,932,315	373	1.93	1.42

(*Estimates for intercensal years are made on the arithmetic basis, or by adding for each one-tenth the increase during the ten years between the two last censuses. By this means some of the yearly rates per 10,000 population differ from figures previously published by the Chicago authorities, based on school attendance, police censuses, and names in city directories.—Ed.)

THE NEW WESTMINSTER BRIDGE OVER THE FRASER RIVER, BRITISH COLUMBIA.

Substructure.

One of the notable bridges recently built on Canadian soil is the double-deck railway and highway structure crossing the Fraser River at New Westminster, British Columbia. This bridge is shown in diagram elevation by Fig. 1. The total length of the main steel structure is 1,780 ft., divided into eight spans of the following lengths, counting from the north end: 225-ft., 380-ft., 380-ft. and five 159-ft. spans. The 225-ft. span is of novel construction, in being 136 ft. wide at one end and 19 ft. wide at the other end, and the second 380-ft. span is a swing span. All the other spans are fixed spans. The superstructure described is carried on piers of stone masonry. It provides for highway traffic on its upper deck, and its lower deck carries a single line of railway track, which at Pier III. branches right and left on 12½° curves, necessitating the peculiar form of span noted above, which has been dubbed a spread span by the engineers. This span, the erection of the bridge by floating the spans into place, and the foundations, which are among the deepest in the world, are the more notable features of the work. The bridge was built for the Department of Lands and Works, Province of British Columbia, by Waddell & Hedrick, of Kansas City, Mo., as engineers, and by Armstrong, Morrison & Balfour and the Dominion Bridge Co. as contractors. Mr. Harry K. Seltzer was the Res. Engr. in charge of the work. It was completed and opened for traffic on Oct. 1, 1904.

CHARACTERISTICS OF SITE.—The site of the bridge is 15 miles from the point where the Fraser River enters the Strait of Georgia. At this point the river at the water line is 2,100 ft., and as there is a tide difference of from 3 ft. to 7 ft. in 24 hours, its waters have two currents each way during most of the year. Under ordinary conditions these currents have a velocity of

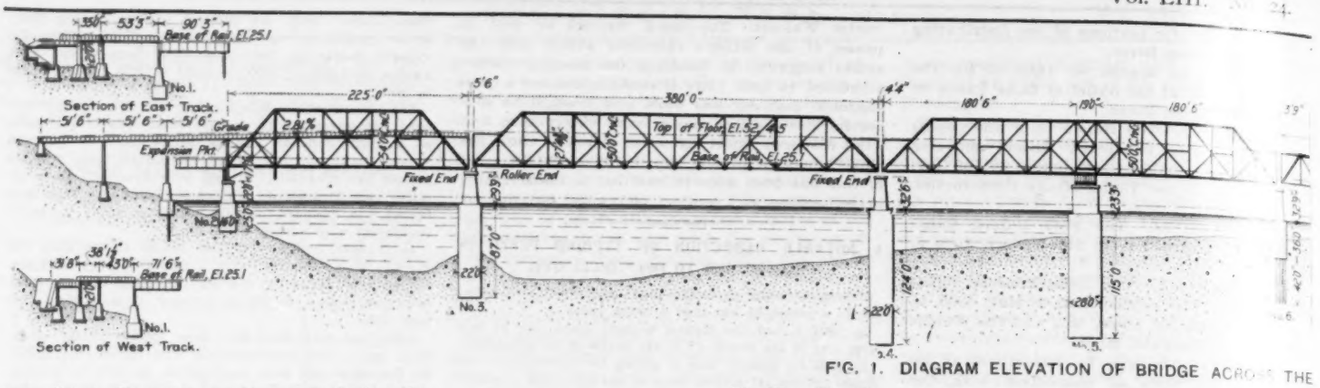


FIG. 1. DIAGRAM ELEVATION OF BRIDGE ACROSS THE

from 2½ to 3½ miles per hour, but during the Spring freshets a velocity of 7 miles per hour has been observed. As indicated by Fig. 1 the north bank of the river is high and the bed of the river from this side drops off rapidly to a point between Piers III. and IV., where there is from 80 to 85 ft. of water at ordinary stages of the river. And this far the river bed consists of a very coarse gravel, interspersed with large boulders, and covered with some 20 ft. of fine silt, containing logs. The remaining portion of the river bed to the south consists of silt, through which occur layers of fine sand, clay and fine gravel.

GENERAL DESCRIPTION.—The substructure consists of 17 piers, 11 pedestals and 3 abutments. All the pedestals and the two abutments on the north shore are concrete. The main pier shafts are of granite masonry backed with concrete. The concrete used for the pedestals and north shore abutments is a 1-3-5 broken stone mixture, faced with 1½ ins. of 1 cement and 2 sand mortar. The pier foundations are of two kinds; Piers I. to V., inclusive, are open caisson or crib foundations, and Piers VI. to XI., inclusive, are pile crib foundations. The cribs in all the pier foundations were filled with concrete of 1 cement, 2 sand and 3 ¾-in. broken stone. The pier shafts are coursed ashlar.

ABUTMENTS AND PEDESTALS.—The concrete abutments and pedestals call for mention only in respect to the forms used. These consisted of 2 × 6-in. dressed and matched lagging boards, supported by a rigid timber frame. The facing was applied by blocking steel plates 1½ ins. from the frame, filling behind these plates with concrete and between them and the lagging with 1-2 mortar, and then withdrawing the plates and tamping the mortar and the concrete together to a close bond. The surface finish secured by these means was remarkably perfect.

PIERS I. AND II.—The foundation denoted as Pier I. consists of three pairs of piers, which carry the steel columns of the one highway and two railway approaches. Each of the six piers consists of a crib 16 × 16 ft., 13 ft. high, surmounted by a concrete shaft 16 ft. high. They were constructed by building cofferdams and sinking the cribs by excavation in the dry with pick and shovel.

Pier II. supports the wide end of the spread spans and consists of two shafts and cribs spaced 136 ft. 6 ins. apart. Each crib is 16 ft. square and 25 ft. high, and carries a masonry shaft 24 ft. high and 10 ft. square under the coping. It was planned to sink these cribs by open dredging inside, but the steep slope of the river bed and the fact that it consisted of cemented gravel filled with large boulders made it impossible to accomplish the task in this manner. A shelf or bench was, therefore, dredged for each crib by cutting down the high side of the bank from 10 to 15 ft. The cribs were seated on the prepared benches and then filled with concrete in the usual manner; their bottoms were protected by riprap.

PIERS III., IV. AND V.—Piers III., IV. and V. are all located in deep water, and consist of masonry shafts founded on timber cribs and caissons sunk by open excavation through central wells. All three cribs were of similar construction, but differed in dimensions and shape. Those for Piers III. and IV. were rectangular and had the following dimensions:

	Pier III.	Pier IV.
Lateral dimensions of crib	22 × 40 ft.	22 × 37 ft.
Height of crib	87 ft.	124 ft.
Wells in crib (two)	8 × 8 ft.	8 × 8 ft.

The crib for Pier V. was an octagon, 28 ft. in diameter, with a central well 12 ft. square, and was 115 ft. high. The shaft for this pier is a cylinder 24 ft. in diameter and 23 ft. 6 ins. high. The shafts for Piers III. and IV. have the following dimensions: Pier III., base, 35 ft. 4 ins. × 13 ft. 10 ins.; height, 27 ft. 9 ins.; Pier IV., base, 11 ft. 6¾ ins. × 32 ft. 6¾ ins.; height, 32 ft. 9 ins.

The construction of the cribs in detail is fairly well indicated by Fig. 2, which gives the drawings for Pier IV. The cribs for Piers III., II. and I. were substantially the same in form and construction, but differed, of course, in dimensions. The octagonal crib had the same solid exterior walls and solid timber cutting edges. In case of these deep-water cribs it was important that the walls should be perfectly water-tight, since any leakage into the dry compartments prevented the dry filling with concrete that was desired, and also rendered possible the danger of foundering

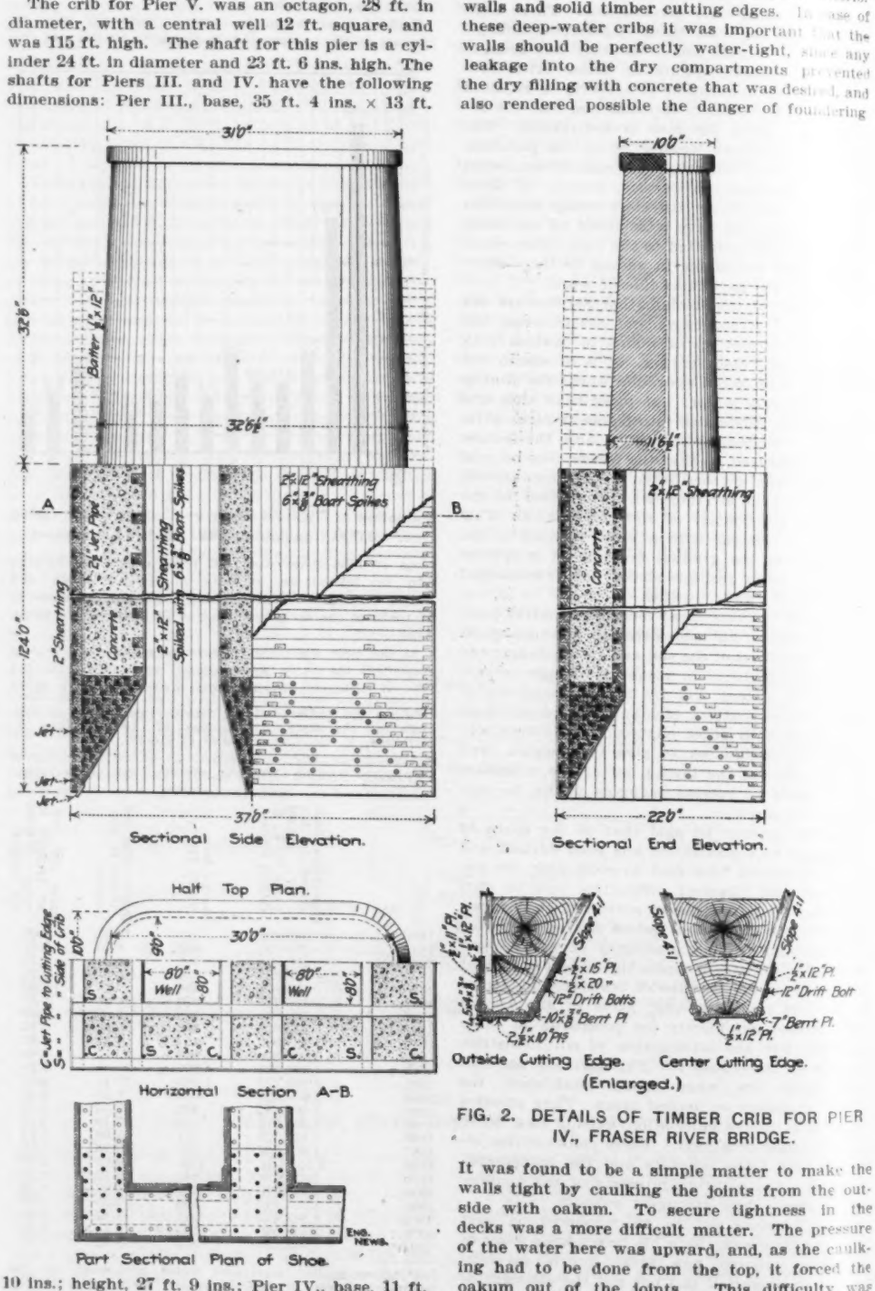
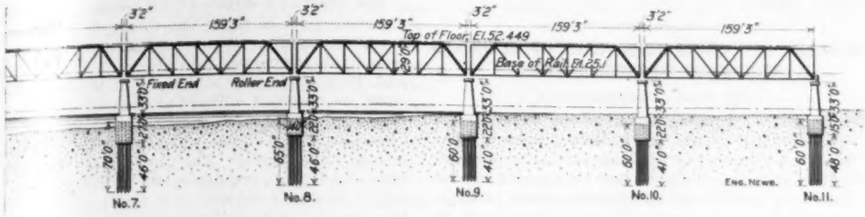


FIG. 2. DETAILS OF TIMBER CRIB FOR PIER IV., FRASER RIVER BRIDGE.

It was found to be a simple matter to make the walls tight by caulking the joints from the outside with oakum. To secure tightness in the decks was a more difficult matter. The pressure of the water here was upward, and, as the caulking had to be done from the top, it forced the oakum out of the joints. This difficulty was successfully overcome by caulking the two topmost courses of deck timbers and then filling all joints flush with hot pitch. Generally, all cribs were constructed complete to a height of 14 ft.

before launching, and when afloat their decks were about 3 ft. above the water surface. Directly after launching the bottoms of the dry compartments were sealed with an 8-in. layer of 1-2-3 concrete, which was allowed to set several days before sinking was begun.



FRASER RIVER, AT NEW WESTMINSTER, B. C.

The usual methods of open-caisson work were pursued in sinking the foundation cribs; excavation was carried on from the surface through the central well and the crib was forced downward by filling the dry compartments with concrete. To hold the cribs in position during the sinking process, they were moored between guide piles within pile docks, whose upstream faces consisted of piles driven close to form a V-shaped breakwater. These docks formed the supports of working platforms. The crib for Pier IV. was landed on the bottom in 50 ft. of water, but during its sinking this depth was increased to 65 ft. by scour. The final depth reached by the bottom of the crib was 135 ft. below ordinary water level. Excavation was stopped in a bed of fine gravel, at a penetration of 70 ft. The crib for Pier V. was sunk to a depth of 125 ft. and landed in a bed of clay and gravel, with a penetration of 90 ft. The original depth of water was 35 ft., but this was increased to 50 ft. by scour. The basins formed around the cribs of Piers IV. and V. by scour were filled with riprap.

The crib for Pier III. was sunk in 80 ft. of water and has a penetration of 45 ft. It is founded in a bed of course gravel and boulders, overlying which there is 20 ft. of fine sand and silt. Owing to the sloping surface of the hard material and the presence of logs in the overlying silt, this crib gave more trouble than any of the others. When the crib landed on the bottom the concrete in the chambers was 35 ft. below water level. The filling was gradually carried up as the penetration increased, but owing to the great height of the crib and to the soft material it was found advisable not to bring the concrete nearer than 15 ft. to the water surface. After sinking 10 ft. into the soft material the crib landed on several logs on its north side, and later again landed on the hard material, which was 18 ins. higher on the north side than it was on the south side. Both of these circumstances caused the crib to lean badly; its total height at the time was 102.5 ft., and it was 4 ft. out of plumb. As any agitation due to excavation in the wells only caused the crib to lean further, the condition was rather serious.

An examination showed that the logs were of considerable size and sound; one of these ran completely across the caisson and was 2 ft. in diameter. It was decided to remove these obstructions by blasting. An augur with a 3-in. bit and a shank 100 ft. long was constructed; its point was set by a diver and it was turned from the top. After boring a number of holes through the log a charge of dynamite was placed in each and exploded. The logs being removed, the crib was loaded on the high side with concrete and stone, and a dredge was set at work taking away the material on the outside of the north cutting edge. This was a tedious task of several weeks' duration, because the soft material overlying the gravel ran so that a large basin had to be excavated. As soon, however, as the dredge began to take away the coarse material the crib began to right itself and gradually came to a vertical position. Riprap was deposited around the base of the crib to fill the basin formed by dredging and scour.

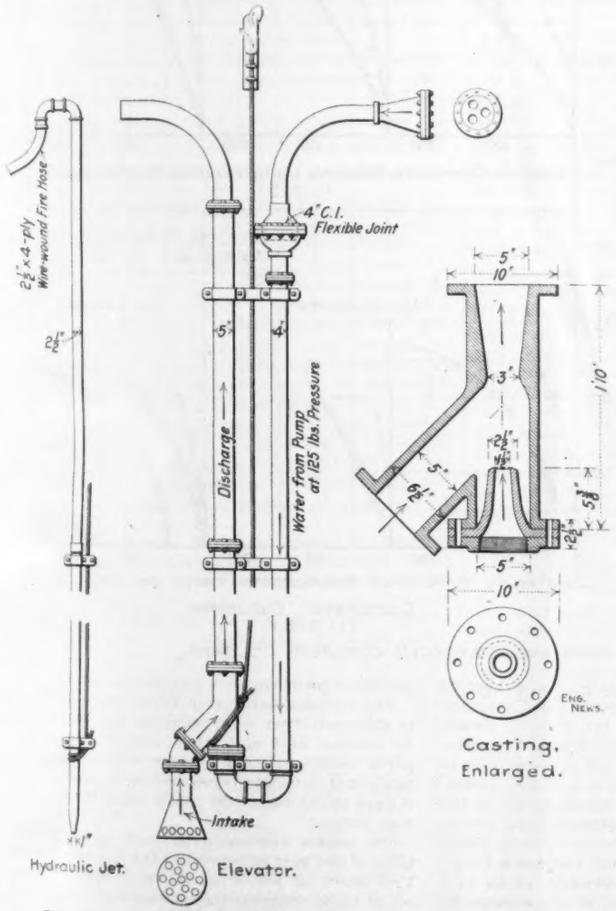


FIG. 3. DETAILS OF EJECTOR FOR EXCAVATING INSIDE OF FOUNDATION CRIBS.

The sinking of the cribs for Piers IV. and V. was straightforward work. All but about 5% of the excavation was done with an ejector or hydraulic elevator of the construction shown by Fig. 3. This device could handle material of any size up to 2½ ins., the diameter of the throat, and was found to be quite as effective at great depths as at smaller depths. The jet shown in the drawing, in connection with the ejector, was used as an agitator; when placed near the suction it greatly increased the efficiency of the work. When coarse gravel or other material was encountered which the elevator could not handle, the apparatus was lifted clear of the bottom and placed in one corner of the well, and a clam-shell dredge was operated for a short time. It was found that the ejector had a decided advantage over the dredge in the point of maintaining the cribs in position. With it, by placing the suction close to the side of the well, the material could be drawn from the high side or the point that was holding up, and by placing an extension on the intake, material could be drawn from directly under the cutting edge. The rate of sinking depended greatly on the material encountered; it varied from 2 to 6 ft. in 24 hours.

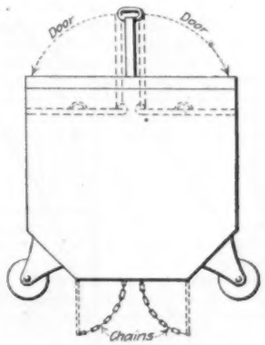


Fig. 4. Bucket for Depositing Concrete Under Water.

The concreting of the cribs comprised two operations; first, the filling of the outside compartments, and, second, the concreting of the central well. In the cribs for Piers IV. and V., as soon as a small amount of penetration had been gained, the concrete in the side compartments was brought above water level and all but the 2-in. sheeting was omitted about the wells. In crib III., owing to the difficulties previously mentioned, it was never possible to bring the concrete to the level of the water surface, and it was, therefore, necessary to continue the solid well timbers to the full height of the crib. The concreting of the wells was done through water until the filling had reached a height at which the well could conveniently be pumped out. In crib V., 75 ft., and in Piers III. and IV., 55 ft. and 65 ft., respectively, were concreted dry. As soon as the wells were laid dry the sheeting between them and the side compartments was torn out so that the inside and outside concrete would have all possible chance to bond. The concrete was deposited through water by means of the special bucket shown by Fig. 4.

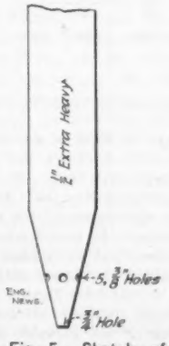


Fig. 5. Sketch of "Rose" Jet for Driving Foundation Piles.

PIERS VI. TO XI.—The six piers carrying the five 159-ft. spans, as shown by Fig. 1, are founded on pile cribs. Each crib, with the exception of No. XI., which is an end pier and contains 21 piles, has 32 piles arranged in four rows of eight piles each. These piles were driven by a hydraulic jet of the pattern shown by the sketch Fig. 5, and known as a rose jet. These jets were developed as a result of unsatisfactory experience with the ordinary single vent jets, which always stuck fast after the pile had been driven, and had to be loosened by sending down a third jet. The rose jets solved this difficulty, and they also

showed greater ability to loosen and penetrate the gravel. Two of them were used on each pile. They were operated with a water pressure of from 150 to 200 lbs., supplied by a Worthington duplex pump with 20 × 12-in. × 14-in. stroke cylinders, 9-in. suction and 7-in. discharge, taking steam at 100 lbs. pressure from two 50-HP. locomotive boilers. The same power plant was used to operate the ejectors.

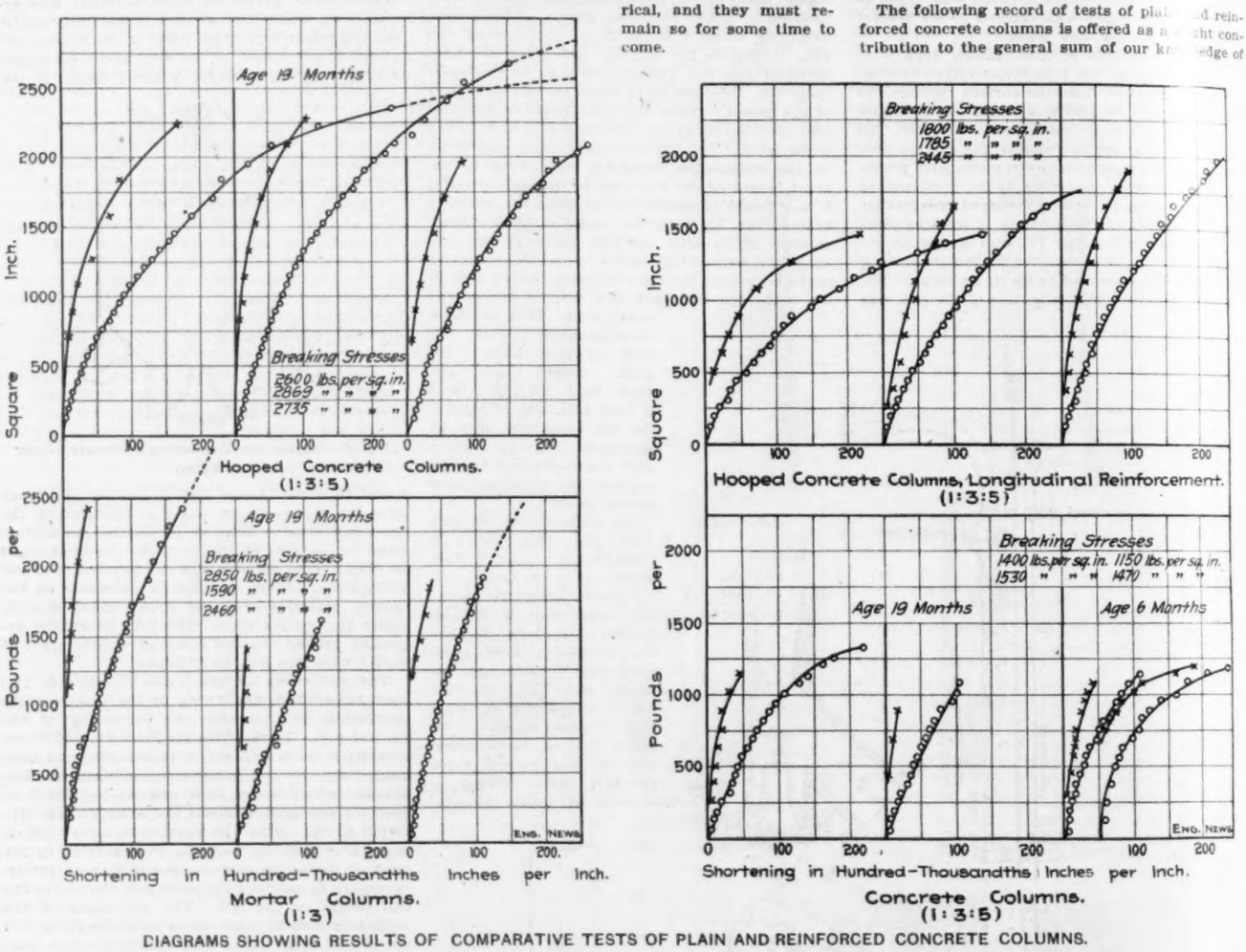
The cribs were made of 12 × 12-in. timbers dressed on two sides, and laid up solid. They were built to their full height about the piles and loaded with stone. The excavation was done with the ejector previously described. The penetration given the cribs varied from 15 to 20 ft. below the original level of the bottom, but the actual penetration, when sinking was completed, was only a few feet, owing to the scour and to the material drawn in from the outside by the ejector. This left the crib standing in a basin, which, in each case, was filled with paving rock, giving the piers a splendid protection below the original level of the bottom. After the cribs were landed they were sealed with from 5 to 10 ft. of rich concrete (1-2-3 mixture), deposited about the piles by steel pipe tremie. This concrete was allowed to stand one week, when the crib was pumped out and cleaned. The piles were then cut off 5 ft. below low-water level, with their tops at slightly irregular heights, after which the remainder of the concrete was brought up in the dry to the base of the cofferdam. The upper cross struts were removed ahead of the concrete.

GENERAL REMARKS.—To carry out the work described, the contractors provided an almost model plant; the principal item was a machinery scow to which was located the boilers and pumps previously described, an air compressor and an electric light plant. Another scow carried the concrete materials and the mixing plant, and several tugs and scows were utilized in transporting materials. Work on the substructure was begun in August, 1902, and was completed in June, 1903.

RESULTS OF COMPARATIVE TESTS OF PLAIN AND REINFORCED CONCRETE COLUMNS.

By E. J. McCaustland.*

In modern building construction much use is made of the reinforced concrete column. The types of reinforcing are usually easily reduced to one of two general classes—a hooping in the form of a continuous spiral, or a series of independent hoops or loops. Longitudinal bars or rods may be used with either class. The pitch of the continuous spiral, and the spacing of the independent hoops are matters more or less empirical, and they must remain so for some time to come.



DIAGRAMS SHOWING RESULTS OF COMPARATIVE TESTS OF PLAIN AND REINFORCED CONCRETE COLUMNS.

In the field of experimentation, spiral hooping has been perhaps, more commonly used than the independent hoop. So far as the writer is aware, no comparative tests have been made of the relative efficiencies of the spiral and the loop form of hooping. It would appear from a casual consideration that the closed hoop should induce in the specimen a higher ultimate strength and modulus of elasticity than would the spiral form: First, because in the case of the spiral hooping a shortening of the column in the direction of its axis will lessen the pitch of the spiral and enlarge its diameter, thus allowing an earlier disintegration of the material with consequent failure, and, second, because this change in the form of the spiral would allow a greater deformation of the material with a consequent drop in the modulus of elasticity of the column as a whole. Again, since concrete either plain or reinforced, takes a measurable amount of permanent set under comparatively light loads, it seems clear [illegible] spiral form of reinforcing is the least [illegible] oppose this action.

The effect of a series of steel ho[illegible] distance apart of about two-third[illegible] ter of the column they are design[illegible] is to divide the column into a series [illegible] and, thus, to develop a higher unit [illegible] could be obtained without the aid [illegible] forcement. Longitudinal bars or rods [illegible] inforcement of columns will increase [illegible] strength but slightly. Their main va[illegible] vide an adequate resistance to any te[illegible] which may be developed as a result [illegible] the column. A very slight buckling [illegible] gitudinal rods relieves them almost [illegible] stress and reduces the resisting power [illegible] umn.

The following record of tests of pla[illegible] forced concrete columns is offered as a [illegible] tribution to the general sum of our kn[illegible]

*Assistant Professor of Mining and Surveying, Cornell University, Ithaca, N. Y.

The columns tested were 40 ins. long and 10 ins. in diameter. They were mixed in the proportions, by volume, of 1 part Alpha Portland cement, 3 parts bank sand and 5 parts broken limestone, using just sufficient water in the mixing to have it flush to the top of the molds when the concrete was tamped.

The mortar columns were made in the proportions of one part of cement to three parts of sand. Two kinds of reinforcement were used. In one set of three columns, eight hoops were used, each ⅛ × 2 ins. in section. These were spaced 5 ins. c. to c., the centers of the end hoops being placed 2½ ins. from the ends of the columns. Another set was reinforced with four hoops of the same sort, and eight longitudinal rods ¼ × 1 in. in section. These hoops were spaced 10 ins. c. to c. the end of the column being 5 ins. from the first hoop. The hoops were made with an outside diameter of 10 ins., and therefore were not embedded in the concrete. This is not the manner in which col-

...s used in buildings would be made up, but for ...sses of testing it is a satisfactory method. ...formations were measured on a gage length ... ins, using an extensometer of the micrometer-screw type, and reading by electric contact to ...000-in. The diagrams are plotted to unit ...es for both stresses and deformations, the latter being in hundred-thousandths of an inch.

The initial load was taken as 1,000 lbs., and adding by increments of 5,000 lbs. (about 64 lbs. per sq. in.), the load was reduced to 1,000 lbs. after each application in order to measure the permanent set. Thus, two curves, Fig. 3, are plotted for each specimen; one, the stress-deformation curve, the other the stress-set curve.

The moduli of elasticity for the various columns were computed at a uniform stress value of 1000 lbs. per sq. in., and the corresponding elastic deformations; i. e., the horizontal intercept between the curves of set and deformation. These values are tabulated for each of the 13 columns, and the averages shown for the separate sets. Excluding the mortar columns, the range in the value of E is comparatively small.

The resilience of a piece under direct stress is defined as the amount of energy which can be stored in an elastic body, and which can be given out again by the body as useful work. Its value may be expressed algebraically as equal to $\frac{1}{2}\frac{f^2}{E} \times$ volume where f = unit stress and E = modulus of elasticity. Values for the resilience of the various columns were computed and are tabulated as are also the average values for each set.

The amount of permanent set taken by a column under load is a matter of much importance in building construction. Hence these values have also been included in the tabulation.

Considère says (page 159 Moisseiff's translation of "Experimental Researches on Reinforced Concrete") that the

compressive resistance of a hooped member exceeds the sum of the following three elements:
(1) Compressive resistance of the concrete without reinforcing.
(2) Compressive resistance of the longitudinal rods stressed to their elastic limit.
(3) Compressive resistance which would have been produced by the imaginary longitudinals at the elastic limit of the hooping metal, the volume of the imaginary longitudinals being taken as 2.4 times that of the hooping.

Applying these conclusions to these tests under consideration, and restricting ourselves to those of like age, we find: Average breaking load for concrete without reinforcement, 115,000 lbs. per sq. in.; volume of eight hoops reduced to rods 40 ins. long gives an area of cross-section of 1.57 sq. ins., and this multiplied by the factor 2.4 gives an imaginary effective area of 3.77 sq. ins. Assuming this to be stressed to the elastic limit of 27,000 lbs. per sq. in., it would offer a resistance of 101,800 lbs. This added to the 115,000 lbs. resistance of the concrete gives a total of 216,800 lbs. The actual test developed a resistance of 214,600 lbs.

For the columns having four hoops and longitudinal rods, the above method of calculation would indicate a probable strength at failure of 219,800 lbs., while the actual test developed only 157,000 lbs. This low value is accounted for by the fact that the rods were not entirely embedded in the concrete, but were free to buckle away from the column between the hoops, and hence were probably never stressed to the elastic limit.

Results of Tests of Plain and Reinforced Concrete Columns

Kind of Column.	Ultimate Strength. Lbs. per sq. in.	—At Stress of 1,000 lbs. per. sq. in.— Mod. of Elas.	Total Set in Ins.	Resilience in in.-lbs.	Elastic Deformation. Inches.
Mortar 1.....	2850	2380000	.0016	1321	.017
" 2.....	1590	1561000	.0032	2070	.025
" 3.....	2460	2498000	.0020	1256	.016
Averages....	2300	2146000	.0020	1549	.019
Hooped 1.....	2600	1240000	.0060	2108	.028
" 2.....	2889	1782000	.0040	1570	.025
" 3.....	2785	1670000	.0060	1884	.024
Averages....	2734	1564000	.0050	1884	.026
Hooped 1.....	1800	1000000	.0240	3140	.040
Rods 2.....	1785	1538000	.0160	2040	.026
" 3.....	2425	1989000	.0100	1700	.029
Averages....	2003	1509000	.0170	2293	.029
Plain 1... Concrete,	1400	1338000	.0120	2198	.028
19 mo 2...	1530	1421000	.0100	2198	.028
Averages....	1465	1378000	.0110	2198	.028
Plain 1... Concrete,	1150	2280000	.0140	1420	.018
6 mo. 2...	1470	1664000	.0180	1884	.024
Averages....	1310	1947000	.0160	1652	.021

THE SCRANTON MEETING OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

The 51st convention of this Society took place last week at Scranton, Pa. The total number of members and guests registered in attendance was 264. The opening session was held on Tuesday evening at the Y. M. C. A. Hall, and welcome was extended to the visitors by Col. F. L. Hitchcock, of the Scranton Board of Trade, Mr. E. M. Zehnder, President of the Scranton Engineer's Club, and Mr. Wm. F. Mattes, Chairman of the Local Committee. This was the Society's second convention at Scranton, the summer meeting of 1888 having also been held there. After response by President John R. Freeman to the addresses of welcome, the reading of technical papers began.

TRANSFER OF HEAT AT HIGH TEMPERATURES.—This paper, by Prof. Frank C. Wagner, of the Rose Polytechnic Institute, recorded experiments in the heating of iron plates in furnaces. A. Le Chatelier pyrometer was used to determine the rate of heating, and figures were obtained for the rate of heat transmission from the furnace to the plate. The material of the paper was of more interest to physicists than engineers, and no one ventured to discuss it. One point of practical interest brought out in the concluding paragraph, however, is worth quotation in full:

If the law of Stefan holds for the radiation and absorption of heat under practical working conditions, as seems to be the fact, then some very significant relationships exist in the transfer of heat to the heating surface of a steam boiler. Compare two cases where the furnace temperatures are 2,000 degrees and 2,500 degrees Fahr. respectively, and a portion of the heating surface is exposed to direct radiation from the fire. The heats transferred by radiation will be as 37 to 77 in the two cases. In other words, adding 500 degrees to the temperature of the fire more than doubles the radiant heat transmitted to the water in the boiler.

STANDARD UNIT OF REFRIGERATION.—Mr. F. E. Matthews, of the De La Vergne Machine Co., in this paper proposed as a standard thermal unit for refrigerating machinery work, the "ton of refrigeration," equal to 288,000 B. T. U. of negative heat and capable of melting 2,000 lbs. of ice from and at 32° F. Numerous standards derived from this were also proposed. No discussion was offered on this paper.

FORMATION OF ANCHOR ICE AND PRECISE TEMPERATURE MEASUREMENTS.—This paper, by Prof. Howard T. Barnes, of McGill University, described some delicate physical experiments made on the St. Lawrence at Montreal to determine the conditions under which anchor ice and frazil form in water. We reprint the substance of this paper separately. There was no discussion.

SOME TYPES OF CENTRIFUGAL PUMPS.—Mr. Wm. O. Webber, of Boston, Mass., in this paper gave some account of the recent development of centrifugal pumping machinery for high lifts. Beginning with a brief resumé of the early history of centrifugal pumps for low lifts, he passed to the recent developments in this field, and we quote as follows:

The first engineer who seems to have discovered the value of compounding centrifugal pumps—that is, by causing the discharge of one centrifugal pump (either integrally formed or simply in close juxtaposition) to be led into the suction of another similar pump—was the celebrated Swiss engineer, Sulzer, of Winterther, Switzerland.

Sulzer was pretty closely followed by A. C. E. Rateau, of Paris, France, and John Richards, and Byron Jackson, of San Francisco, Cal. All of these pumps were constructed originally with the impellers facing in one direction, and the consequent thrust upon the impellers was partially taken up by balancing chambers upon the rear of each impeller. This form of balancing was further improved in Rateau's pump by a balancing cylinder at the extreme discharge end of the pump shaft, into which water was admitted from the discharge orifice of the pump. Rateau further attempted to improve the balancing of his pump by constructing inclosed impellers, having one of the side plates of the impellers of smaller diameter than the other, so that the area of the two impeller side plates subjected to the discharge pressure from that impeller was equal.

John Richards also used a balancing piston at the discharge end of the pump, directly connected with the discharge pressure, and also attempted to further balance a pump of this type by exhausting the air from one side of the impeller and forcing air in upon the other side.

Another method of balancing the end thrust of centrifugal pumps was by false vanes located upon the outside of the side plates of an inclosed impeller, these being designed to relieve the pressure upon the outside of such impellers, by establishing a counter-flow through the space around the periphery of the impeller and causing a partial vacuum to exist. By making these false vanes of different radial lengths on the opposite sides of the impeller, the end thrust can be counteracted for any given set of conditions; but it is not believed that a pump thus provided with balancing vanes will remain in good operative balance if the original conditions are changed.

The diffusion vanes, which form a distinguishing feature of the turbine type of pump, are located in the usual whirlpool chamber of the centrifugal pump in such a manner as to convert the water leaving the impeller at a high tangential velocity into a direct radial flow. This also has the effect of overcoming the eddies formed by the water leaving the impeller, thereby reducing the excessive internal friction.

This construction, therefore, causes a centrifugal pump to assume the converse of a turbine water wheel. The direct radial flow becomes of great importance in compound centrifugal pumps where the liquid being pumped is to be passed from one impeller to another. Many different forms of these diffusion vanes have been devised, and John Richards seems to have been the first one to form these diffusion vanes in a removable annular ring surrounding the impeller, and as these parts are subject to considerable wear, their removal and replacement are thus rendered convenient and inexpensive.

Sulzer then made the greatest step in the balancing of compound pumps by placing the impellers back to back in pairs, so that one impeller thrust in one direction and the next impeller thrust in the opposite direction. The method which he used, however, of conveying the liquid being pumped from one impeller to the next required short, tortuous passages, and he utilized the fixed guides in the whirlpool space of the pump to form these cross-over passages; also, it is believed, that to Sulzer we are indebted for the idea of introducing the guide blade or turbine element.

John Richards followed Sulzer in placing two impellers back to back, and differed from Sulzer in passing the discharge from one impeller out and around the discharge chamber of the final impeller, but only showed this construction in a two-stage pump.

Hochruck and Sulzer both locate their impellers back to back in pairs, and pass the liquid from one impeller through lateral passages located between the radial vanes of the stationary guides surrounding the peripheries of each pair of impellers. In this form of construction, while the sum of the discharge pressures in one direction balance the sum of the discharge pressures in the opposite direction, any variation in the suction pressures will throw such a pump out of balance.

This is evidenced in that all of the constructions of Sulzer, Richards, Rateau and others show a thrust-bearing and balancing piston at the discharge end of their pumps, which they have specifically stated was put there for the purpose of overcoming the residual thrust.

It is the opinion of the writer that there should be no thrust, residual or otherwise, left over or unbalanced, in a properly constructed pump.

The writer believes that he is the first one to design an absolutely balanced compound centrifugal pump, by causing the impellers to be placed back to back, but not in pairs serially disposed; and in producing results, from the method in which he sequentially connects the different impellers, so that both the sum and difference of the suction and discharge pressures of all the impellers in any compound centrifugal pump equalize and balance each other.

Carl Lager, of Syracuse, New York, has also designed a pump in which the sum and difference of the suction and discharge pressures of all the impellers in any compound centrifugal pump equalize and balance each other, but accomplishes his result by placing his impellers in pairs, facing each other, with a diaphragm on an angle between the two impellers, he confining his discharge from one impeller to a certain locality upon the periphery of the pump and not entirely around the periphery.

With the present type of multiple stage centrifugal pumps, this pump at once offers the solution of pumping large quantities of foul or dirty water, often impregnated with foreign material, to a considerable height, such as the pumping out of iron, coal and other mines.

The combination of this type of pump, directly con-

nected to high-grade compound condensing steam engines, provided with automatic cut-offs, presents an economical type of water-works pumping engine, occupying approximately one-sixth of the room of the ordinary high duty pumping engine, and costing one-sixth as much, and giving duties very nearly in comparison to the best engines of these types.

For instance. A 20-in. six-stage pump directly connected to a 15-30 × 16-in. compound engine, with steam at 200 lbs., would easily give a duty of 90,000,000 ft. lbs. per 1,000 lbs. of dry steam. This pump would be capable of lifting 20,000,000 gallons of water, per day of 24 hours, to a height of 185 ft., and with 100° of superheat and 28 ins. of vacuum, such an outfit would readily give from 100 to 105 million ft. lbs. duty.

These pumps, directly connected to electrical motors, present practical solutions of many unique problems where it is desired to pump water to extreme elevations. The writer recently figured on a plan of this sort, to pump a thousand gallons of water a minute to a height of 6,000 ft., using five compound units, each pumping 1,200 ft., two pumps working in series constituting each unit with a motor between. This insulation was designed for furnishing a water supply for the British summer capitol at Simla, India.

This type of pump has come to stay and offers a solution for sinking pumps in deep workings, for submerged pumping, for auxiliary pumps for water-works, and many other combinations where electrical driving will allow of operating at a distance and without local attendance. They are also, from their extreme simplicity, absence of valves, etc., as nearly impossible of getting out of order and as nearly "fool-proof" as it is possible to make modern machinery. They occupy a minimum amount of space, can be operated in any position, can be made infinitely strong, do not get out of repair readily, and can be repaired easily, and the working parts renewed readily at a minimum expense.

Considerable discussion was aroused by this paper. Mr. H. V. Henshaw, of New York, suggested the applicability of centrifugal pumps to oil pipe lines, and pointed out that the centrifugal pump is more suitable than any other type for electric motor driving. Mr. Chas. N. Trump, of Wilmington, referred to the large centrifugal pumps built by the Southwark Foundry & Machine Co., in 1884, for the Mare Island dry-dock, California. These were designed by the late John H. Cooper and were the first very large centrifugal pumps for dry-dock work built in this country.

Mr. Frederick Ray, Engineer of the centrifugal pump department of the Worthington Works, while approving the general idea of the applicability of the new type of centrifugal pump to a wide variety of uses, expressed doubt as to its applicability to replace high-duty water-works pumping engines, at least when a reciprocating engine was used to drive it as proposed by Mr. Webber. Perhaps the steam turbine may be improved to a point where its direct connection to the centrifugal pump will create a unit that can rival the present high-duty engine.

The discussion was further continued by Messrs. Morse, Supplee, Lewis, Rice, Zohe, Mattes and Freeman.

WEDNESDAY MORNING SESSION.

A short business meeting was held at the opening of this session in which Mr. C. W. Hunt gave a brief report of progress on the Union Engineering Building. He stated that the building has been planned not alone to accommodate the three societies now taking part in it, but as a general home and headquarters for engineering societies. It is the aim to make it an engineering and scientific center for the whole country. Bids for the construction of the building are to be opened on June 16.

It was also announced that the venerable Chas. H. Haswell, who has just celebrated his 90th birthday, has been elected an Honorary Member of the Society. Also that the Council has fixed on Chattanooga, Tenn., as the place for holding the spring convention of 1906.

MICROSTRUCTIVE AND FRICTIONAL CHARACTERISTICS IN BEARING METALS.—Prof. Melvin Price, of Lincoln, Neb., recorded in this paper the results of some researches carried out at Columbia University in the field designated in the title of the paper. While the research involved a vast amount of labor, the results obtained were inconclusive and appeared to have little or no direct application to practical work. The paper was briefly discussed by Messrs. Moss, Taylor, Supplee and Freeman.

CRUSHING STRENGTH OF CAST IRON.—Mr. W. J. Keep, of Detroit, Mich., in this paper gave detailed results of compressive tests of cast iron specimens, supplementing the voluminous series of tests of cast iron for transverse and tensile strength which were recorded in Vol. XXV. of the "Transactions." There was no discussion on the paper.

SMOKE PREVENTION.—The concluding paper of the morning session was by Prof. Chas. H. Benjamin, of Cleveland, and is printed nearly in full elsewhere in this issue. A brisk discussion followed the reading of the paper. Mr. A. Bement, of Chicago, said that mechanical stokers frequently failed to prevent smoke. He favored a long passage lined with refractory tile between the furnace and the boiler heating surface to give the gases time to burn before entering the tubes. Mr. John T. Hawkins pointed out that there is no economy in merely saving smoke, the fuel value of the escaping soot being trifling. Mr. Geo. H. Barrus believed stokers were too expensive for steam users generally to adopt them, and for small plants they were wholly inapplicable. Mr. Hirschman described the McLean blower system by which in the Fuller Building in New York City No. 2 buckwheat coal is being successfully burned.

Mr. Miner said that in firing locomotives, the "one-shovel" system, much talked about a few years ago, has been rendered obsolete by the growth in size of modern locomotives. He instanced a case where a locomotive burned 50 shovels full of coal in half an hour. The fireman had to fire six or seven scoops full at a time. Mr. Blauvelt said that any saving by mechanical stokers was counterbalanced by the charges for interest and repairs. After further discussion by Messrs. Taylor, Parker, Ball, and others, the session adjourned.

WEDNESDAY EVENING: STEAM ENGINEERING.

Four papers on steam engineering topics occupied the session on Wednesday evening. Mr. A. S. Mann, of Schenectady, discussed the question: "Can a steam turbine be started in an emergency quicker than a reciprocating engine of the same power?" He gave the results of experience in operating a steam turbine station which is run as an auxiliary to a high-tension water power station which during the construction stage had frequently to be shut down and its load thrown on the steam turbines. We reprint part of the paper as follows:

The station is equipped with three Curtis turbine-driven alternators, 40 cycle, 10,000 volts, each of 1,500 KW. normal capacity. During the summer months the station is operated as an auxiliary to a water-power plant, taking all sudden overloads.

A signal has been arranged (a ¼-in. whistle) so that it can be blown instantly should the power fail. A blast of that whistle means—cut in two turbines and bring the third up to speed. The load will be heavy, and all auxiliary apparatus must be in regular operation.

Each turbine has a surface condenser and there are three or four pumps to be started for each pair of turbines; one circulating pump, one combined hot-well and feed pump, one pressure pump for the step bearings and one dry air pump, all of which are motor driven. The exciter is driven by a steam engine and must be started also, for it supplies current to a portion of the auxiliary apparatus.

The boiler-room has steam up at all times, supplying a system for manufacturing purposes other than power, and slow fires are kept in enough boilers to make steam needed for the normal load. Forced load means forced fires. The boilers have under-feed stokers, equipped with pressure blast, and will respond quickly to a 50% excess call for steam. The operating force for this is about equivalent to a force for an engine-driven plant. Engineers and oilers, however, are busy about the building on construction work, installing new apparatus and taking such work as their regular occupation when the turbines are not running.

At the sound of the whistle the water-tender starts a blower on the extra row of boilers: all blast dampers are opened up and all stokers are allowed to feed at the maximum rate. Each fireman dumps his free ash and bars over his red fire.

The man in charge of the coal and ash conveyor starts the pressure pump for step bearings. One of the turbine men starts the exciter which supplies current to the auxiliaries beside its field current; a second turbine man starts the circulating pump and then his turbine. The hot-well pump and the air pump are started by the oiler. These movements take place simultaneously [illegible] force is organized upon the lines that obtain in a fire station; each man has his specific duty, and after [illegible]ing it looks to see that there is nothing more [illegible] to do. Only a few seconds elapse between starting [illegible] pump and starting the first turbine. The turbine [illegible]ile is opened as fast as an 8-in. steam valve [illegible]pened without endangering the steam piping system. [illegible] not considered advisable to open the throttle valve [illegible]st as a man's strength will permit; but if nothing [illegible]sual occurs in the pipe line, sentiment does not spoil [illegible] turbine.

One electrician attends to the switchboard [illegible] telephone. As soon as the machine approaches [illegible], the synchronizing system is cut in and the main [illegible]s are got ready. One and one-half minutes will [illegible] the work here outlined, including the time taken in [illegible]ering the crew from various parts of the building, [illegible] not a trivial matter.

Manipulating an engine regulator so that it shall [illegible] at a precise speed and at an exact phase relation [illegible] from some other machine, not more than 1-1,500th of a second removed from it, is no matter that can be hurried, and one minute is fast time on such work. But the whole thing, phasing-in and all, has been done in 2½ minutes, including full load on the turbine, which started from a standstill.

This performance has been gone through a great many times, and our record book shows that out of [illegible] such calls, 10 starts were made in 2½ minutes, 18 in 3 minutes and 15 in 3½ minutes.

We have taken the time in a number of instances when all the auxiliaries have been in motion and it only remained to start the turbine and phase it in on the line; the only valves to open in such cases are the throttle and one small oil valve. The two quickest starts have been made in 45 seconds and 70 seconds, respectively, including phasing in. Others range between one minute ten seconds and one and one-half minutes. These two quickest starts were made on a turbine which had stood for twenty-four hours with the throttle valve shut tight though there was a slight leakage past the seat. After the throttle valve is off its seat it is not more than thirty seconds before the turbine is up to speed. A cross-compound reciprocating engine of the four-valve type, 2,250 HP. capacity, can be brought up to speed from a standstill in five minutes if it is hot all over. This five minutes is to be compared with the 70 seconds required for the similar turbine operation.

A reciprocating engine, which is turning over slowly with the throttle valve just off its seat or with by-pass open and having all its oil cups open and regulated, can be brought up to speed, say 75 turns, in two 2½ minutes. This can be compared with the 30 seconds necessary for bringing the turbine up under the same conditions; that is, about one-fifth the time necessary for bringing up the engine.

If the engine is cold all over and has all its oil cups shut tight, all its auxiliaries quiet, 15 minutes is called a rapid start. Starts have been made under such conditions in twelve minutes. When we start a cold turbine, we open up the valve and let her turn, and in two minutes we are ready to bring her up to speed and she will be at speed in 2½ minutes, dividing the engine's time by more than four.

Mr. R. H. Rice, of the General Electric Works at Lynn, remarked that in testing a new 1,500-KW. steam turbine, it was their practice to bring it up to full speed in 15 minutes from the time the steam was first turned on.

Two papers by Mr. A. Bement, of Chicago, were next on the program. The first related to the basis on which the efficiency of various parts of a steam plant should be computed and the separation of boiler efficiency from furnace efficiency was insisted on. The paper was briefly discussed by Messrs. A. A. Cary and Wm. Kent. Mr. Bement's second paper described a test of a Babcock & Wilcox superheater, with 1,000 sq. ft. of heating surface attached to a B. & W. boiler with 5,000 sq. ft. of heating surface. The superheating produced was from 145° to 182° with variations in output of 500 to 800 HP. Mr. Geo. H. Barrus, of Boston, took exception to the figure for the specific heat of steam (0.75) assumed by Mr. Bement in the paper and described tests which pointed to a specific heat far below this figure.

A new type of valve-gear in which the valves are moved by steam, was described by Mr. W. H. Collier, of Jackson, Tenn. The valves are moved by small steam cylinders to which steam is admitted and released by a small rotating piston valve, which is turned by gearing from the main engine shaft. The gear is very simple and cheap compared with the ordinary Corliss valve gear and was claimed to give a perfect steam distribution with close regulation of speed and ability to

...gasoline at higher rotative speeds than any reliable valve gear. This gear has been in daily use ... months on a 14 × 30-in. engine running at ... p. m. in the power plant of the Southern ... & Boiler Works at Jackson, Tenn., of which Mr. Collier is Superintendent. The gear is ... to be applied to an air compressor. It is claimed to be also adaptable to any stationary or locomotive engine having two or more valves.

The paper was discussed by Messrs. F. M. Rites and R. H. Rice. The former thought that if actual tests bore out the claims in the paper, the device might be a distinct advance in steam engine design. Mr. Rice, however, apprehended that wear and leakage of the controlling piston valve would, in time seriously affect the steam distribution and predicted that these and other practical difficulties would prevent the device from becoming a commercial success.

THURSDAY MORNING SESSION.

A brief paper by Mr. H. G. Reist, of the General Electric Co., proposing standard heads for machine screws, was first on the program and is printed separately in this issue.

Next followed a paper entitled "Belt Creep," by Prof. W. W. Bird of the Worcester Polytechnic Institute. The paper described tests on 4 and 6-in. leather belts on 18-in pulleys, from which it was concluded that the creep of a belt should not be over 1%. In the discussion doubt was expressed whether the experiments covered a wide enough variation in pulley sizes to make the results generally applicable.

THE FUNCTION OF LABORATORY COURSES IN ENGINEERING SCHOOLS.—Prof. Lucke, of Columbia University, in this paper condemned the "cut-and-dried" shop courses of some engineering schools, in which the average student too often performs tests and fills out blanks in a mechanical way and does little planning or thinking for himself. Instead, Prof. Lucke advised setting the student at work to solve engineering problems, not necessarily wholly original investigations, such as are usually designated by the term "research," but such problems as will tend to stimulate his powers of thinking and planning and turning to practical application what he has learned in his text books. The paper was discussed and heartily commended by Professors Hugo Diemer, A. L. Williston and D. S. Jacobus.

The next paper by Mr. E. N. Trump, of Syracuse, described a new type of apparatus for measuring granular materials together with a new concrete mixer. It is reprinted elsewhere in this issue. There was no discussion.

Admiral Geo. W. Melville's historical paper on naval steam engineering, presented at one of the monthly meetings last winter, was read by title and also a discussion upon it by Mr. John T. Hawkins in which he related the attempts of the late F. E. Sickels, the inventor of the Sickels cut-off, to introduce high expansion ratios in naval vessels in the days of low steam pressures and single cylinders.

The concluding paper of the meeting was by Prof. D. S. Jacobus describing the method adopted for balancing a large horizontal engine. We reprint this paper separately.

After adopting resolutions of thanks to those who had taken part in the entertainment of the Society, the meeting finally adjourned.

EXCURSIONS.

As not infrequently happens at meetings of this society, the excursions offered to the visitors proved more attractive to a large percentage of the visitors than the technical sessions. Those of the Society who arrived early on Tuesday spent the afternoon visiting the works of the McClave-Brooks Co. and the Pine Brook coal mine and breaker, located in the heart of Scranton. The Pine Brook mine has been in operation nearly 50 years. Its shaft is about 300 ft. deep and the new breaker just completed at its mouth has a capacity of 2,000 tons prepared coal per day. About 1,000 men are employed in the mine and breaker.

On Wednesday afternoon no session was held and the whole society visited the International Correspondence Schools, all parts of which were thrown open to the visitors' inspection. These schools have now nearly 800,000 pupils enrolled and the methods adopted for their instruction were examined with great interest by the visitors, who were also escorted through the large printing plant operated in connection with the schools. Carriages then conveyed the party to the Scranton works of the Allis-Chalmers Co., formerly the Dickson Machine Works, where a variety of heavy machine work in process of manufacture was examined.

On the afternoon of Thursday a special train on the Delaware, Lackawanna & Western R. R. conveyed the visitors to the new Keyser Valley car shops of that company, which were opened last January, and to the Hampton 2,500-KW. power plant designed for the distribution of electric current to a number of different collieries. A large water hoist at this place elevates water from a shaft 500 ft. deep. There are two buckets each of which holds 17 tons of water and each makes a round trip in 1 minute, 55 seconds. The hoist is driven by an electric motor and is automatically stopped and started, a very remarkable example of the application of automatic control to very large units.

On Thursday evening the Society was given a reception by the local members, the Scranton Engineers' Club, and the Board of Trade.

Friday was devoted to an excursion to Wilkesbarre over the new third-rail electric line of the Lackawanna & Wyoming Valley R. R. Co. At Wilkesbarre the party visited the plant of the Vulcan Iron Works, builders of light locomotives and mining machinery, and Colliery No. 5 of the Lehigh & Wilkesbarre Coal Co. Return was made to Scranton in time for departure on the evening trains.

CUTTERS FOR HYDRAULIC DREDGES WORKING IN HARD MATERIAL.

The accompanying illustrations show two kinds of cutters for hydraulic dredges working in hard material. The cutters have been made for the American Dredging Co., of 5 Market St., San Francisco, for use in dredging near Oakland. The material encountered is described as a hard, sandy clay, which, when deposited in the fill, is like cobble stones, and is hard enough to walk on. With an ordinary cutter three 9-in. steel

Fig. 1. For Hard Material.

Fig. 2. For Very Hard Material.

CUTTERS FOR HYDRAULIC DREDGE AT ALAMEDA, NEAR OAKLAND, CAL.

shafts were broken. The breaks showed no flaws in the steel.

The cutters as a whole are 8 ft. in diameter and 4 ft. long. For the softer of the hard material the cutter is of one piece of chilled steel, 2½ ins. thick, formed into three wide teeth, as shown. For the hardest of the material seven removable chilled steel teeth are used. The cutting ends of the teeth are sharpened as shown. The other ends are about 3 × 4 ins. in section where they fit into the shank, and within the shank they have a conical taper.

In the hardest digging the dredge on which these cutters are used has taken out 50,000 cu. yds. per month. In the softer hardpan it has taken out 80,000 cu. yds. per month, and during the month of April, 1905, while digging soft, muddy material, with some sand and soft clay, it took out 333,000 cu. yds. in 27 days' work, discharging this material ashore through 3,600 ft. of pipe line.

For the information given we are indebted to Mr. L. J. Le Conte, M. Am. Soc. C. E., U. S. Assistant Engineer in charge Oakland Harbor Works, Flood Building, San Francisco.

SMOKE AND ITS ABATEMENT.*

By Chas. H. Benjamin,† M. Am. Soc. M. E.

The smoke nuisance has long been one of the bugbears of living in the middle West and is now rapidly becoming an important factor in the East.

The fact might as well be recognized at once that the supply of so-called smokeless fuels, anthracite coal, petroleum, natural gas, etc., is limited and will not begin to satisfy the demand. The supply of bituminous coal on the other hand is practically unlimited, and it is doubtless the fuel of the future. The abundance of it, its cheapness and the readiness with which it burns, even with a poor draft, combine to make it a most desirable fuel. This granted, the further fact remains that it will be burned to a larger and larger extent in the East as well as in the West and that no legislation can prevent this. Just as anthracite coal becomes more scarce and its price increases, just as surely will its place be taken by the cheaper and more abundant fuel.

The problem for our engineers and lawmakers is not how to prevent the burning of soft coal, but how to burn it in such a way that the combustion shall not be a public nuisance. The present discussion will then be confined to the problem of abating the smoke from bituminous coal. The word abatement is chosen with a reason and the terms smoke prevention and smoke burning are discarded. It is not practicable to prevent the evil entirely, but only to mitigate it in a degree. Smoke burning on the other hand is an impossibility under the conditions which usually present themselves.

It will be well at the outset to state three propositions: (a) The smoke from bituminous coal is a nuisance, especially in large cities. (b) Such smoke can in the majority of cases be easily abated. (c) Such abatement can be made a source of profit to the owner of the plant as well as to the community. There need be no difficulty in establishing these propositions by precept and by example.

Objectionable black smoke is due to the presence of hydro-carbons in the fuel and is produced as follows: The hydrogen and carbon compounds in the coal are driven off as gas by the heat at a comparatively low temperature, and may escape unburned. In this condition they would not constitute smoke in the common sense of the term. If heated to a sufficiently high temperature in the presence of air they burn with a yellow flame. If the air supply is insufficient, is poorly mixed with gas, or if the temperature is lowered in any way, combustion is checked and carbon is deposited in the form of soot or carried off with the gas as smoke.

It is difficult to form any estimate of the amount of

*A paper presented at the Scranton meeting of the American Society of Mechanical Engineers.

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damage inflicted by soft coal smoke in a city like Pittsburg or Cleveland, but it probably amounts to hundreds of thousands of dollars annually.

The abatement of smoke is in principle extremely simple, but presents some difficulties in the practical application. Only three conditions are necessary for complete combustion, the proper temperature, the proper air supply, a thorough mixing of the air and the hydrocarbons. The last condition is as important as any and is one too often neglected. It is this condition which gives the gas or liquid hydrocarbon an advantage over the solid, since the atomizing of the former by the steam or air jet insures the most intimate contact between the air and the fuel. The use of pulverized coal in combination with air or steam is a close approximation to the above, and, when properly managed, gives good combustion, no smoke and a high efficiency. The cost of pulverizing and the impracticability of storing pulverized fuel have so far hindered the more general adoption of this process, except for metallurgical work.

When coal in the ordinary form is used as fuel, smoke abatement involves some means of varying the coal supply and the air supply according to the demands made upon the boiler. When ordinary hand firing is resorted to, the great irregularity of the coal supply will cause poor combustion and smoke unless the air supply is varied to correspond. Steam jets are frequently employed under these circumstances, and, if properly put in, will improve the combustion by drawing in additional air over the grate and mixing it with the products of combustion in front of the bridge wall. The steam jet should be semi-automatic, the steam and air being turned on by the opening of the fire door and gradually closed off by a dash-pot attachment.

The best solution of the smoke problem, so far, has come from the introduction of mechanical means of handling the coal, which give a uniform feed to the fuel and a corresponding delivery of air for combustion. The use of mechanical stokers has been brought about by the natural demand for machine handling in large power plants as more economical than human labor, rather than by a philanthropic desire to benefit the community.

Stokers may be divided into three principal classes: Inclined, shaking grates—traveling or chain grates—and underfeed stokers. The inclined grate, as exemplified in the Wilkinson, Brightman and Roney stokers, has a hopper in front and slopes down and back, having a clinker grate just in front of the bridge wall, while the double incline, as in the Murphy and Detroit stokers, has a magazine on either side and slopes in two planes parallel to the axis of the boiler, meeting in a clinker grate at the bottom. The principle of action is practically the same and involves the slow coking of the coal on a dead-plate, the pushing forward on to the top of the incline and the gradual descent, impelled by oscillation of the grate bars, until the combustion has left nothing but ash and clinker at the bottom. Air is usually admitted both below and above the grate, and the hydrocarbons which are distilled at the top of the grates pass through the intense heat of the burning coke on their way to the bridge wall and are completely burned. The double incline usually has a revolving clinker bar which disposes of some of the ash automatically, but as a rule both forms need considerable cleaning. When used with a fuel which does not cake or clinker too much and when not crowded too hard these stokers are economical and reduce the smoke considerably. If, however, it becomes necessary to slice and poke the fire on account of caking coal or overcrowded boilers, unburned masses of coal are rolled to the bottom and holes are made in the fire through which cold air rushes. Both of these circumstances make for poor combustion and a smoky fire. As a rule firemen poke the fire on stokers too much, doing more harm than good.

I have seen inclined grate stokers carrying a heavy fire and developing much more than the rated capacity of the boiler with very little slicing and hardly a trace of smoke. Cleaning is usually a source of black smoke for a few minutes, but this is mostly unnecessary if the fireman understands his business and gets his fire ready for cleaning beforehand. I think the middle door in the Murphy furnace is sometimes a disadvantage, as it tempts the fireman to meddle with the fire when he had much better leave it alone.

The traveling or chain grate is rapidly coming into favor as a means of stoking automatically. It consists, as in the Babcock & Wilcox and Green stokers, of an endless horizontal chain running on sprocket wheels and carrying the coal back under the boiler, finally dumping the refuse over the back and into the ashpit. The distilling process and the gradual burning of the coke are much the same as in the stokers just described. In order to prevent waste through the grates the latter are usually quite close, and it becomes necessary to use more draft than with ordinary grates. A damper is used underneath the grate to prevent an excess of air from passing up behind the grate. Some tests recently made by a large corporation which uses a considerable number of the chain grates showed an evaporation of only 5.7 lbs. of water per lb. of coal. An examination disclosed the fact that a large excess of air was passing through the comparatively bare grate at the rear end. The introduction of a damper to regulate this brought about a great improvement. With the same fuel and same conditions as before an evaporation of 8 lbs. of water per lb. of coal was obtained. Intending users of chain grates would do well to bear this in mind. From observations covering a period of several years I have come to the conclusion that this type of grate is the best one yet devised for abating smoke. The fact that it is horizontal, so that unburned coal cannot run to the rear end, and the further fact that it is self-cleaning and need not be disturbed by the slice-bar, make it an almost ideal furnace in this respect. If run by an intelligent fireman who understands adapting the depth and travel of the fire to the work to be done, it will also be a very economical furnace.

The underfeed stokers operate on an entirely different principle, the coal being fed in underneath the grate and forced up through a rectangular opening in the center. A forced blast is used and the air for combustion is blown up through the coal, the tuyeres being on either side of the rectangular opening just mentioned. By this arrangement the fresh coal is always underneath and the distilled gases are obliged to pass through an incandescent mass of fuel in company with the air. With a proper pressure of blast perfect combustion is thus almost unavoidable. The ash and clinker are now at the top of the fuel, which forms a gradually rising mound in the center and pushes the clinker over to either side, whence it is removed by hooks through doors at the front. The heat generated is such that the ash generally melts and forms a sheet of clinker which can be easily removed without disturbing the fire. In the American stoker the coal is forced under the grate and up by a revolving screw, somewhat similar in shape to the ordinary gimlet pointed lag screw. In the Jones underfeed stoker a plunger driven by steam operates to feed the coal. This plunger can be arranged to start and stop by hand or to run automatically. My experience has shown the underfeed stoker to be economical in operation and practically smokeless. A criticism frequently made in regard to mechanical stokers is that they will not respond quickly to sudden changes in the load, that it is difficult to keep a uniform steam-pressure under such circumstances, and that for this reason they are not economical. There is some truth in this. It is easy to conceive of circumstances, especially in electric plants, under which it would be difficult to maintain a uniform steam pressure with either the oscillating or the traveling grate.

For regular fluctuation of load, as in electric lighting or railway power-houses, the obvious remedy is the introduction of storage batteries and the provision for ample boiler reserve. Minor fluctuations can be taken care of by the fireman unless they become too numerous or too violent. In the latter case the underfeed stoker with the plunger feed comes the nearest to satisfying the demand. With the power of instantly regulating the motion of the plunger and the pressure of the blast, it is thus possible to meet emergencies of this kind more promptly than by hand firing.

With the complaint sometimes made that stokers cannot be forced I have no sympathy. With an ordinary inclined grate stoker under a horizontal tubular boiler I have forced a boiler to 25% above its rating with practically no smoke and with an evaporation of over 8 lbs. of water per lb. of bituminous slack. It all depends upon the draft and upon the intelligence of the fireman. It may be stated as a general proposition that smoke abatement means economy in fuel consumption. The proof of this statement is extremely simple: fuel economy results from good combustion, good combustion is accompanied by little visible smoke.

It must be remembered that the converse is not necessarily true, for a smokeless chimney does not always mean good economy. An excess of air may insure entire oxidation of the combustible matter and at the same time so dilute the chimney gases as to cause serious waste of heat.

Whenever for any sufficient reason the stoker can not be introduced, there are other devices which will mitigate the smoke nuisance considerably and also save fuel. The steam and air blast has already been mentioned. A recent improvement which promises well is the combination of steam jets at the bridge wall with oil vapor, creating an intense heat at that point and consuming the hydrocarbons as they pass through. The expenditure of oil is comparatively small and considerable economy is said to result.

Brick arches and baffle walls have also assisted in maintaining a high temperature and in properly mixing the gases. The use of a reverberatory furnace or outside oven in which the coal and its gases are thoroughly burned before going to the boiler is another satisfactory method of reducing smoke, and may be used with as well as without a stoker. In short, whatever produces good combustion abates smoke. In apartment houses and stores where the boilers are used for heating only and the steam pressure is low, the use of fuels which are comparatively smokeless is about the only [illegible] solution.

If the use of such fuels is supplemented by [illegible] and careful firing, the results will be reasonably satisfactory.

Locomotive engines present an entirely new [illegible] conditions requiring treatment radically different [illegible] accorded to stationary plants. Several mechanical [illegible] have been designed for use on locomotives, and [illegible] of these at least has been fairly successful. This [illegible] is still in the experimental stage, however, [illegible] too early to pronounce upon its future.

Most railroad companies have to rely entirely [illegible] the skill of their firemen for abating the smoke [illegible] within city limits and some of them have made [illegible] improvement in this respect. Regular and careful [illegible] vations during the years 1900, 1901, on the railroad entering the city of Cleveland, showed a reduction [illegible] the average amount of smoke emitted by locomotives [illegible] from one-half to two-thirds, as a result of the so-called [illegible] shovel system of firing, without any change in the [illegible] nace or equipment. The introduction of brick arches [illegible] also proved to be a good investment.

In closing, I wish to call attention briefly to the [illegible] gal aspect of the question, although this may not [illegible] interest engineers as much as does the scientific aspect.

I believe that the municipalities have a right to insist upon the abatement of black smoke by all users of steam boilers, without regard to the purposes for which the steam is used or the means to be adopted for abatement This, because smoke is a public nuisance and because it can be abated without hardship to the owner of the plant. Nevertheless, when the evil is present and has been present for a period of years, it is not good policy to be too radical in the enforcement of the statutes. The law should be definite and stringent and the penalties adequate, but they should be enforced with discretion by officials who have some technical and practical knowledge of smoke abatement.

It is absurd to talk of putting this matter into the hands of the police or of the health officer. The official having charge of this work should be a trained engineer, if possible a technically educated man, and he should be entirely above graft in any of its disguises.

When the public comes to realize its rights in this matter and that it is under no more obligation to submit to this nuisance than it is to endure bad drainage or filthy streets, laws will be enacted and enforced and the people will wonder that they so long submitted to this unreasonable imposition.

A CONTRACTOR'S SIDE-LEVELER.

By George W. Lee,* Jun. M. Am. Soc. C. E.

On railroad work, one of the most useful appliances for a contractor or a railroad company engaged in widening roadbed with standard plant is a side-leveler. The machine consists of a wing capable of being swung outward and down, and, acting as a plow, levels the completed fill to the exact subgrade, leaving it ready for the ties, rails and ballast of the new track.

There are several of these machines on the market, more or less elaborate in their construction, and generally expensive to purchase. The machine herewith illustrated, however, can be readily and quickly built on the work at a moderate cost, and will pay for itself over and over again, doing the leveling in a most satisfactory manner.

These side-levelers are particularly useful where the filling material has been plowed from flat cars by the Rapid Unloader & Equipment Co.'s machinery, and, in such cases, are coupled to the rear of the work train and bring the fill to the proper grade as fast as it is unloaded. The side-leveler illustrated has a wing on one side of the car only, but it is of course preferable to have a duplicate wing facing the opposite direction on the other side of the car. When constructed this way, the machine is always ready to grade the fill on either side of the main line track, and is more evenly balanced, it being unnecessary to load the outer side down with rails, as is the case when but one wing is used.

The mast, guides and braces are constructed of heavy white oak, and must necessarily be put together in the strongest manner, as the strain against them is very heavy, especially when the filling material contains considerable rock. The wing frame is 7 × 9-in. white oak, with the verticals dapped 1 in. into the top and bottom chords. At the side of each vertical timber are ¾-in. tie rods, staggered, the heads in the bottom chords

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ding countersunk in cup washers, and the nuts to bear against malleable iron washers. Upon the frame of the wing a ⅜-in. plate is bolted in two pieces for convenience in handling and renewal, and this is reinforced at the bottom by a ½-in. plate 7 ins. wide. The part of the plate overhanging the frame, as shown in Fig. 2, is stiffened by having an old dipper tooth riveted at both the top and bottom. The bottom chord of the frame is also covered with a 9 × ½-in. plate to prevent wear.

A socket on the back of the wing is so placed as to fit over a similar socket fastened to the side sill of the car when the wing is folded back, and an iron bolt may be slipped through these sockets, holding the wing firmly to the car side when running with it out of service. When in use, these sockets and a similar one on the bottom chord are used for braces made of old rails, which hold the wing open.

For raising and lowering the mast, a No. 19 Barrett track jack is used, placed on the deck of the car back of and between the guides. The foot of the jack engages a lug attached to the mast. When necessary to transfer the leveler from one job to another, the mast is raised to the full height of the jack, blocked there by slipping a bolt through a hole in the mast over the iron guide clamps, and the lug removed and lowered as far as possible. The wing can then be jacked up some 18 ins. or more, which leaves the bottom well clear of any obstruction and in a suitable position for shipment.

The bottom of the mast should be protected by a heavy iron shoe to prevent wear, as shown in the drawing. A 6 × 6 × ½-in. angle bar should be bolted at the back and across the bottoms of the guides; this angle, extending up on the braces, stiffens them and holds the foot of the mast in place. It is necessary also to have a flanger fastened under the car and in front of the wing, so as to throw any spilled material from the track.

The wing hinges should be very strong, and we have found 1 × 4-in. iron the best for the purpose.

On long fills, when a shoulder of special form or distance from the track is desired, a shaping plate can easily be made and attached by bolts to the wing plate. The use of such a plate leaves a bank of remarkably fine appearance.

As regards the cost of this machine, we have built several of them attached to our own cars, and in general the cost would be about $175 for one wing complete, outside of the value of the car.

We have used them with great success on our work of constructing the Oak Grove Yard for the New York Central & Hudson River R. R. in Pennsylvania; also on the double-tracking of the Fall Brook R. R., and the reconstruction of the Chateaugay Railroad in the Adirondacks. As a labor and time-saver, the side-leveler is on par with the unloading machine.

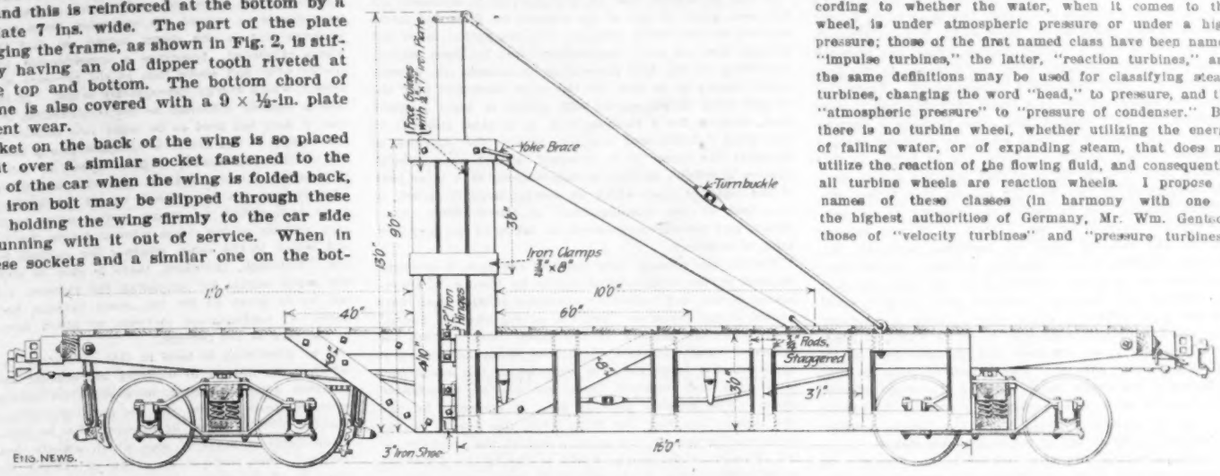

FIG. 1. SIDE ELEVATION OF A CONTRACTORS' SIDE-LEVELER.

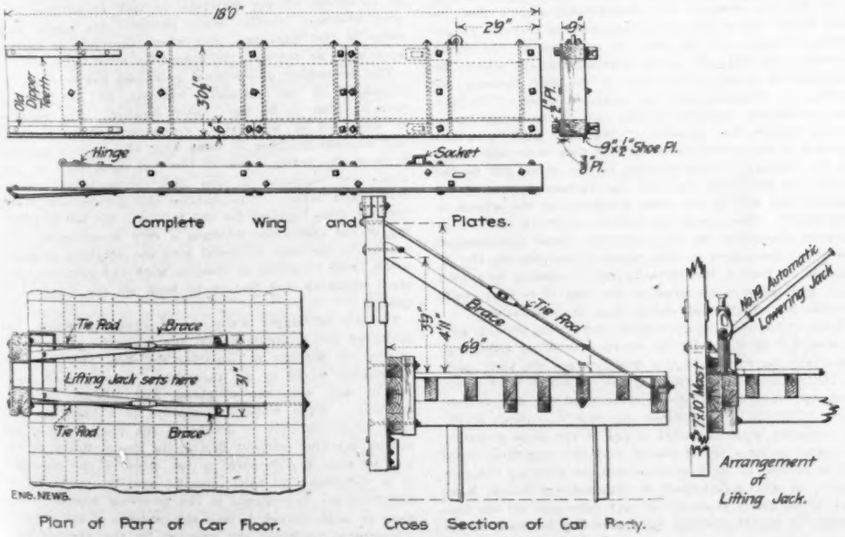

FIG. 2. DETAILS OF THE SIDE-LEVELER.

THE STEAM TURBINE.*

By Storm Bull,† M. W. S. E.

Hero's contrivance, the first heat engine of which any record has been preserved, was but a reaction steam turbine, and since his time (about 200 B. C.) others have attempted to utilize the energy of the steam in similar manner, but it was not until 1884 that the Englishman, Parsons, succeeded in building an axial reaction wheel of 10 HP., which made 18,000 revolutions, and which was a practical success. The real history of the steam turbine, therefore, dates from the year 1884. Another important date in this history is 1889, in which year the Swede, de Laval, brought out his turbine, and, which certainly is very remarkable, in almost the same form as it is being made to-day. These two kinds of steam turbines are the foremost representatives of the two most extreme types of this new motor, between which there is a very large number of types.

*Abstract of a paper read before the Western Society of Engineers, Chicago, June 7.

†Professor of Steam Engineering, University of Wisconsin, Madison, Wis.

It seems rational to use the same classification for both water and steam turbines, although the fact that the steam turbine uses a compressible fluid, makes possible a very much larger variety of turbines than is possible in water turbines. These latter are classified according to whether the water, when it comes to the wheel, is under atmospheric pressure or under a high pressure; those of the first named class have been named "impulse turbines," the latter, "reaction turbines," and the same definitions may be used for classifying steam turbines, changing the word "head," to pressure, and the "atmospheric pressure" to "pressure of condenser." But there is no turbine wheel, whether utilizing the energy of falling water, or of expanding steam, that does not utilize the reaction of the flowing fluid, and consequently, all turbine wheels are reaction wheels. I propose as names of these classes (in harmony with one of the highest authorities of Germany, Mr. Wm. Gentsch) those of "velocity turbines" and "pressure turbines;" so that, for instance, the de Laval turbine, would be a velocity turbine, and the Parsons, a pressure turbine.

The classification of steam turbines is not quite as simple as for water turbines, the reason being the possibility and practicability, when using steam, of introducing the multiple stage turbine. With steam of even fairly moderate pressure, the velocity of efflux into vacuum, is several thousand feet per second. According to both theoretical and practical hydraulics, the velocity of rotation of the moving blades or buckets, should be not far from half of that of the steam, in order to get the best efficiency. For steam of 150 lbs. pressure by the gage and a vacuum of 27 ins., the velocity of the steam is not far from 4,000 ft. per second; consequently the velocity of rotation should be nearly 2,000 ft. per second. De Laval lets his smaller size turbines run with 30,000 revolutions per minute, and in that manner obtains a velocity of rotation which is not far from what it ought to be. For turbines of greater power, the maximum capacity being 300 HP., he found it necessary to use a larger wheel, and the limit of the size is determined by the number of revolutions and the strength of the material of which it is made. With these larger sizes the number of revolutions had to be cut down to some 15,000, even though they are made of the very strongest nickel steel, and the velocity of rotation is only about 60% of what it ought to be for the very highest efficiency of the turbine. It has been found impossible to go higher than 300 HP., notwithstanding the most careful study of the problem, and de Laval had to invent the flexible and self-adjusting shaft before his turbine could become a practical success.

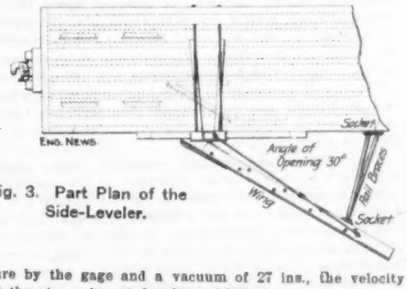

Fig. 3. Part Plan of the Side-Leveler.

The purpose of the multiple steam turbine, is to get around this difficulty, with respect to the high velocity of efflux of steam. Instead of changing the energy of the steam all at once into kinetic energy in a nozzle like that of de Laval, this may be done in several steps, the energy corresponding to each step being utilized or absorbed by the wheel before the next step is reached. If, for instance, there are 50 steps—as in many of the Parsons turbines—and the difference between the pressure in the boiler and condenser be 150 lbs., then the average drop for each step is only 3 lbs., and the corresponding velocity of the steam comparatively small. However, the impression must not be left that in a multiple stage turbine the pressure drop is constant for all the wheels. It may be so, but ordinarily it is only approximately so, and it is not essential to a high efficiency. By this method, then, it is possible to have a very much smaller velocity of the steam, and consequently an equally smaller

velocity of rotation, so that the troublesome problem of finding a material which could withstand the centrifugal force generated by the high rotation speed has been got rid of.

The Curtis steam turbine is the best known velocity turbine in the United States. In this the steam flows from a series of nozzles (somewhat like those of de Laval) into the first turbine wheel, from which it flows through a guide wheel into a second turbine wheel, the pressure remaining nearly constant from the entrance to the first until the exit from the second turbine wheel. From this latter the steam collects in a small reservoir, and is then expanded through nozzles and flows through a turbine wheel, again through a guide wheel, to a second turbine wheel and into a second reservoir, and so forth. In this manner there may be three or four pressure stages, each one subdivided in two velocity stages, this latter subdivision serving also to reduce the velocity of rotation The turbine invented by Mr. Rateau, of France, belongs also to the velocity class of turbines, although Mr. Gentsch classifies it as a pressure turbine. In this turbine there are as many pressure stages as there are turbine wheels, and the space between each turbine wheel and the next following guide wheel, forms a reservoir from which the steam flows into the guide wheel, in passing which the steam expands and changes part of its heat into kinetic energy. The important point is that expansion of the steam takes place on the guide wheels, except so far as it is necessary to overcome the resistance in the turbine wheels; hence the Rateau turbine is a velocity turbine, but of many pressure stages.

In multiple-stage pressure turbines, the pressure is gradually reduced from the moment the steam enters the first guide wheel until it enters the condenser. The expansion of the steam takes place both in the guide and turbine wheels, the velocity of the steam also increasing, and more rapidly, toward the end than to begin with. The most prominent example of the class of steam turbines is that of Parsons, which is now being built in large numbers, and up to 10,000 KW., in nearly all of the large industrial centers of the world. Depending on the pressure of the steam and of the power of the turbine, the number of wheels in a Parsons turbine may be as large as 80, although about 60 probably is more nearly the average. It is of course quite possible to build a Parsons turbine with a very much smaller number of wheels, and evidently such a turbine would be very much cheaper to build. The drop of pressure would then be correspondingly greater for each wheel, also the velocity of the steam as well as that of rotation, and consequently the number of revolutions. If, therefore, it be desired to design a wheel with a comparatively low number of revolutions, it is necessary to use a large number of wheels, and presumably this consideration has been the leading one at least in the choice of the number of wheels in the Parsons wheel as it is built.

The various considerations suggested above explain why there is such a great difference in the number of wheels in the principal makes of turbine wheels. It is, however, probable that the difference will grow less and less as experience accumulates. It must be remembered that the successful steam turbine is very young in years, and there is room for a very large amount of experimental work of a very intricate nature and on a large scale to determine various problems in the working of the steam turbine. Notwithstanding this lack of positive knowledge, the steam turbine has certainly made giant strides forward, and it is not to be doubted that it is still very far from having reached its greatest state of perfection, and that it has a still more brilliant future before it. There are various reasons why the steam turbine, notwithstanding the failure of many designs and of the apparent newness of the idea, has been able to obtain such a marked success. First, the idea was really an old one, and more work had been done than people in general were aware of. Second, the reciprocating steam engine had apparently reached the highest perfection which it was possible to impart—so that inventors had to turn their efforts into a new channel if they were to expect noteworthy results. It is true enough that the efficiency of the reciprocating steam engine has been increased considerably during the last 15 or 20 years by means of the use of superheated steam; but this gain in economy is shared by the steam turbine as well, so that their relative position is not changed because of the use of superheated steam. Third, because of its purely rotative motion the turbine avoids those irregularities of motion which are inherent in the reciprocating steam engine even if it be provided with the heaviest fly wheel. The popular idea that the change from the reciprocating and rectilinear, to the rotary motion involved great losses, did not contribute to this success, as all competent men were fully aware that these losses were imaginary. Fourth, the steam turbine occupies much less space than its rival, a very important consideration in large cities and on shipboard. Fifth, it can be regulated much more closely than the steam engine, because of the very short time (only a very small part of a second) that the steam occupies in passing through the steam turbine, the corresponding time for the reciprocating engine being many times greater. As a consequence of several of the reasons already given, the steam turbine is better adapted for direct connection to an electrical generator (especially alternators) than the steam engine, and in this electrical age this circumstance has weighed heavy in the balance.

It will be noticed that an improvement in economy has not been given as one of the reasons for the rapid introduction of the steam turbine, and the author is of the opinion that no such improvement has yet been shown. According to the best knowledge possessed, the present status seems to be that for the most favorable load the reciprocating steam engine still seems to have a slight lead, whereas for a variable load, as is most frequent in electrical lighting and traction plants, the opposite is probably the case. It is, however, almost impossible to express a definite opinion in this respect, as a large part of the material upon which an opinion must be based, is furnished by the manufacturers of the turbines themselves, and consequently cannot be taken as the very best kind of evidence.

Mention has already been made of the gain in economy realized by the reciprocating engine by the use of superheated steam, and numerous examples of such gain were quoted in my paper on "The Use of Superheated Steam" read before the Society in November, 1903. From the tables of results of tests of various steam turbines it is apparent that large gains in economy of the steam turbine have also resulted from the use of superheated steam. The reasons for this gain in economy for the two motors are very far from being the same. In the reciprocating engine, the gain is due to the reduction of the cylinder condensation, which is due to the difference of the temperature of the saturated steam and of that of the cylinder walls and head, which condensation is greatly intensified by the moisture in the steam adhering to the metallic surfaces. In the steam turbine, this difference of temperature is necessarily very much smaller, as no exhaust steam comes in contact with the parts which come in contact with the steam on its way through the turbine. On the contrary, if the barrel of the steam turbine is well protected, the temperature of the inside of this barrel can be but very little different from that of the steam at that particular place, hence the condensation due to this cause is certainly small compared with that in the reciprocating engine. Because of the absence of moisture on the cooler surfaces touched by the steam, this condensation will be reduced in the same ratio as for the reciprocating engine, but the difference of temperature being so small, this gain, because of the absence of moisture, can only be insignificant. However, even in the ideal case of an adiabatic expansion, condensation is inevitable, if saturated steam be used, and such condensation will be prevented if the steam be sufficiently superheated so that its temperature may be lowered without its becoming saturated. In this respect the steam turbine and the reciprocating steam engine are on the same level as to the possible gain due to the use of superheated steam.

So far, the analysis has unmistakably shown that the last named motor has the advantage; but there is an additional reason for the gain in economy by the steam turbine, and that is in the reduced friction which the superheated steam encounters on its way through the turbine as compared with the saturated steam. This friction is entirely negligible in the case of the reciprocating steam engine, but because of the very high velocities utilized in the steam turbine it is a very important factor in its economy. This friction is not alone due to the motion of the steam through the various wheels of the turbine, but also to the rapid revolution of the wheels in this steam. How much the friction amounts to it is at present impossible to say, although some experimental work has been done in this direction, notably by Dr. A. Stodola, of Zurich, Switzerland; but it amounts to a good deal, and there is no question but that it is very much smaller for superheated steam than for saturated.

Tests of turbines using superheated steam show a gain in economy of about 1% for every 8 or 9° of superheat. Especially instructive in this direction are the tests made by Dr. Stodola on a Zoelly turbine, in which both saturated and superheated steam were used for the various tests. For 122° of superheat the gain was about 13½%, as compared with saturated steam of the same pressure. It ought perhaps to be stated that the superheat must not be carried so far that the steam, on entering the condensor, is still superheated—a circumstance which, however, is not likely to occur, for any superheat for the production of which practical apparatus can be made at the present time.

A steam turbine can, of course, be run non-condensing, and its efficiency, if designed for this purpose, is probably as good as that of the non-condensing engine. But it is a fact, which is established by a large number of tests, that it is very much more important to have a good vacuum or a steam turbine than for a reciprocating engine, because the gain in economy is very much greater. It is therefore not unusual to hear of 28-in. vacuum for a steam turbine, and such high vacuum has only become possible by the introduction of new and improved condensors and air pumps, which owe their origin to the demands of the designers of the steam turbines. Why the gain in economy, because of a high vacuum, should be so much higher for the steam turbine than for the ordinary steam engine, is a question which has troubled a good many persons. The answer is, however, quite simple. Because of the increased condensation, it has been found unprofitable to extend the expansion down to the low pressure line in the steam engine, so that the steam when exhausted, possesses a considerable amount of energy over and above that at the pressure of the condensor, which energy consequently is lost. In the turbine this is entirely different, as the condensation is so small that it does not need to be taken into consideration, and the energy of the steam is changed into a kinetic form and which, in amount, is proportional to the difference in pressure between that of admission and of condensation. This energy can be utilized, except for friction losses, down to a certain minimum, corresponding to the necessary velocity of the steam when it leaves the last wheel, and which is the same whether the vacuum is high or low. Although, therefore, there is gain in economy for the steam engine by increasing the vacuum, yet it will not be so great as for the steam turbine, because the losses of condensation increase so much more rapidly in the case of the turbine.

It is interesting to note in this connection the success achieved by Rateau in utilizing the exhaust steam from a steam hoisting engine, at a mine for driving a low pressure steam turbine. As the hoisting engine was only running intermittingly, he inserted what he calls a steam accumulator—a mass of iron which absorbs heat during the time when there is an excess of exhaust steam, and gives it off by evaporating water, when there is a deficiency, in this manner enabling the turbine to run continuously.* An intermittently running engine like the hoisting engine can hardly be run condensing, because it takes too long a time to produce the vacuum. But a steam turbine with the accumulator can utilize the exhaust steam with a comparatively high efficiency, as is fully shown by the tests of such turbines in operation. In one test with a pressure of 14.71 lbs. absolute the consumption of steam per electrical HP. per hour was only 39.97 lbs. per hour, and for a pressure of 9.37 lbs. absolute it was 42.78 lbs.

A NOVEL MACHINE FOR MECHANICALLY MEASURING THE INGREDIENTS OF CONCRETE AND GRANULAR MATERIALS GENERALLY.†

By E. N. Trump,‡ M. Am. Soc. M. E.

Many chemical and metallurgical processes require the accurate proportioning of the raw materials in a crushed or powdered form, and their intimate association by mixture until the particles are near enough together to admit of the desired reactions. The success of these processes largely depends on the accuracy of the proportions, as an excess of one material, or lack of another, may give irregular results. Many products are simple mixtures of raw materials, and where the color or appearance must be uniform, the proportion must be perfect.

The developing of chemical processes has been an enlargement of the chemist's methods, and we find the favorite plan to be the "batch method." The material is measured or weighed in convenient sized "batches" and brought together in some kind of a mixing machine to be mechanically thrust or tumbled about until the particles are supposed to find their proportional distance from each other. The smaller the batches are made, the less time required for the mixture, but the multiplying of the operations becomes a very monotonous occupation for the men intrusted with the weighing or measuring, soon resulting in careless work and requiring constant checking and testing to keep up the standard of quality.

The use of hopper scales, or of automatic scales, has improved the proportions, but the materials are still delivered in batches of considerable size, and must be thoroughly mixed by an intermittent process corresponding in time with the weighing, and difficult to make automatic. Even when the mixture of a batch is good it is often difficult to discharge the product from the mixing machine without destroying the accuracy of the mix because a difference in the sizes of the particles, or a difference in their specific gravity, tends to redistribute the ingredients in the receiving hopper, which must be large enough to hold the contents of the mixer.

Weighing machines are affected by the varying condition of the materials, which stick to the hoppers, or the dust which clogs the delicate balances. The gates used to feed the weighing hopper, or discharge its contents, leak, and foreign substances clog or prevent their proper action.

Where the material contains varying amounts of mois-

*Engineering News, Sept. 29, 1904.

†Slightly condensed from a paper read at the Scranton meeting of the American Society of Mechanical Engineers.

‡General Manager and Chief Engineer, The Solvay Process Co., Syracuse, N. Y.

ture frequent tests must be made and the weights changed to obtain the proper portion of dry material.

The measuring of batches of material is subjected to the variations in the personal equation of the attendant. The height of fall into the measure, the temperature and condition of material, the method of striking off surplus, the amount of tamping the material receives, all affect the result.

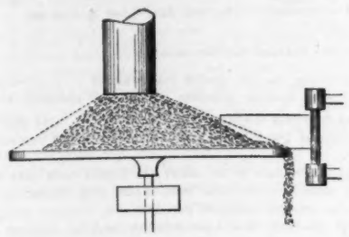

Fig. 1. Revolving Table; Effect of Variations of Natural Slope Upon Discharge.

CONTINUOUS MEASURING AND MIXING.

Many machines have been made, and are in use, to proportion materials and mix them continuously. It is recognized that much saving of labor in handling, and greatly enlarged outputs, will result from proper methods. The first element of continuous mixing is a continuous feed, which will be rapid and accurate, and not affected by varying conditions of the materials, or at least adjustable to these conditions. The following methods may be mentioned:

Screw Conveyors: Are used for discharging a stream from a hopper, the quantity being regulated by a sliding gate at the end or by changes in speed.

Shaking Spouts: Operated under a hopper to move the material delivered upon it.

Revolving Pockets: Receiving material from a spout and emptying into a spout below.

Revolving Rolls: Arranged to feed a measured quantity by the distance between them, or from a spout by extending the natural slope.

Reciprocating Tables: Moving horizontally under a spout, and moving the material out over its edge.

Revolving Tables: With stationary spout grinding material out until it falls over its edge, or is diverted by an inclined blade.

Each one of the above methods is in use in various forms, with different degrees of success. Some of them work well on a particular material, but most of them are affected by changes of speed, pressure from the hoppers holding supplies of material, changes of moisture, or size of crushing. Nearly all of them depend for accuracy on the natural slope assumed by the material as it discharges from a spout, and as the natural slope which the material assumes in falling out of a spout is changed by any variation in pressure from above, size of material, content of moisture, and speed of delivery, all of these affect the accuracy of the delivery.

Of the methods mentioned above the revolving table, with a stationary spout above its center, has been considered the most accurate, and is much used in cement manufacture for feeding mills, etc. Its defect is the change in the natural slope of the material, which varies the amount cut off by the diverting blade as indicated by dotted lines in Fig. 1.

If we make the table of relatively large size and distribute the material in a uniform layer upon it, as shown in Fig. 2, the stationary knife, or diverting blade, may be pivoted so as to take off a predetermined quantity in one revolution, and if the layer is thin, variations in the natural slope on the edge will affect the accuracy very little. As the table revolves the stationary knife will divert the material in front of it over the edge of the table and it will fall in a continuous stream into the chute. If the material is replenished on the table so that the layer taken off by the knife is restored to exactly the same shape as before, and is continuously removed by the knife, an accurately measured quantity will be diverted.

By adding to the table a bottomless storage cylinder, somewhat smaller in diameter, with its lower edge spaced a distance above the table sufficient to clear the knife and yet near enough to the table so that the material flows out from under the edge of the cylinder and takes its natural slope, we shall have the condition represented by Fig. 3. The cylinder being supported by arms from the central spindle may be filled to the top by means of the chute, and as the knife removes the section represented by its path over the table, the material from the cylinder above will take the place left vacant, and will come out under the edge of the cylinder to the extent of its natural slope. While this slope may vary a little this variation is a very small part of the amount diverted by the knife, and as the material composing nearly the whole base of the cylinder is cut away the space behind the knife is filled from above with nearly uniform pressure, and in practice the natural slope angle is almost exactly the same, in spite of considerable differences in height of material within the cylinder.

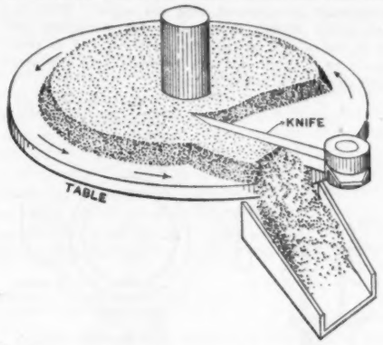

Fig. 2. Revolving Table with Diverting Knife.

After deciding on the distance between the bottom of the cylinder and the table, and the width of the knife, the other factors, which determine the amount of material measured off in a given time, are the speed of rotation and the depth of the cut of the knife, and these are both adjustable. The depth of cut of the knife is adjusted by swinging the knife around on its pivot so that it extends a greater or less distance into the material. This swing is controlled by a screw attached to an arm, cast as part of the knife, and a micrometer scale with pointer shows the amount of movement. This is shown in Fig. 4.

The mechanism described above may be employed for the feeding of a great variety of materials, varying considerably in size and consistency, and if the size of the table, the shape of the cylinder, and the size of the knife and space between the cylinder and the table are properly adjusted, almost any kind of crushed material may be fed.

The variations in size may extend from fine powders, like cement, to rocks of 6-in. cube. In the case of the larger sizes the space between the bottom of the cylinder and the table is made considerably higher than the height of the knife, as the space between the bottom of the cylinder and the top of the knife must be sufficient to let the largest pieces pass through without catching. The amount diverted by the knife is not dependent upon its height, but on the height of the space under the cylinder.

As an example, in the case of a table 12 ft. in diameter, feeding rocks of 6-in. cube, the variations for a single revolution, where some 6,000 lbs. were diverted, showed less than 2.5%, and for 10 revolutions the variations were less than ½% of the quantities. With finely powdered materials the variations in the quantities by volume are considerably less than this.

A measuring table of 3½ ft. in diameter is being used as a meter measuring the quantity of powdered material delivered to a series of furnaces. The quantity was formerly ascertained by passing the material through a hopper scale, where batches were continuously weighed by an attendant. The measuring table was calibrated in different positions of the knife, and the total quantity measured by it was checked for two consecutive months. The variations from day to day, where 12 to 15 tons of material were measured, were less than 50 lbs., and the total differences for a month, for a measurement of 400 tons, showed in one case 108 lbs., and in the other case 150 lbs. As these variations were both sides of the average, the results of the scales were as doubtful as those of the measuring machine.

The same machine filled to the top of the cylinder was revolved and the material for each revolution weighed separately, the depth of the cylinder being about 3 ft., the quantities for each revolution were within 0.1 lb. of each other, on a weight of 5 lbs., and no variation occurred until the material reached within 6 ins. of the bottom of the cylinder, when it began to decrease a little in quantity for each revolution.

Having now obtained a method of measuring the materials, the proportioning of two or more materials, and the subsequent mixing, becomes a matter of the combination of two or more cylinders. Two measuring machines, such as have been described, may deliver into the same spout, and may be driven at different speeds, or the same speed, and by adjusting the knives any proportions may be secured.

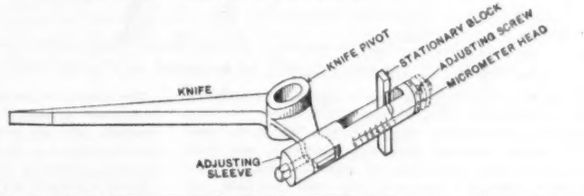

FIG. 4. METHOD OF ADJUSTING KNIFE TO VARY RATE OF FEED.

As the function of a perfect mixer is to deliver the materials in the proper proportions in as close contact as possible, it is important to bring them together in superposed sheets while falling from the table, so that little subsequent mixing will be required. To reduce the amount of mechanism, therefore, and have only one revolving part, the arrangement shown in Fig. 5 is adopted.

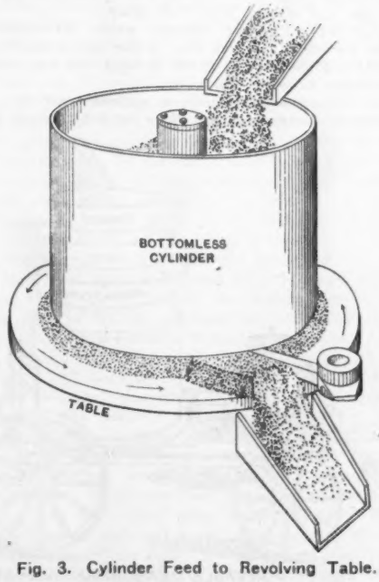

Fig. 3. Cylinder Feed to Revolving Table.

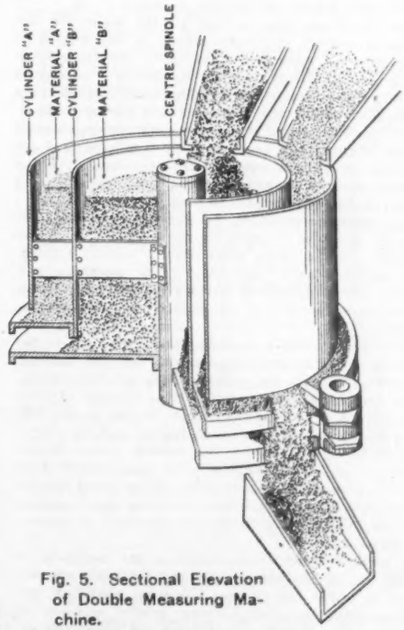

Fig. 5. Sectional Elevation of Double Measuring Machine.

The two or more tables are set one above another, and the cylinders supported from the same spindle, so that they all revolve together. Each table has its own storage cylinder, or annular space between the cylinders, and for each table there is a knife with its own adjusting mechanism. These knives may be ad-

justed at will to vary the percentage of material in a mixture, and when the proportions are approximately known, the width of the knives and the distance between the cylinders and the tables are fixed at approximately the average desired. As the material is diverted over the edge of the upper table it falls into the material coming from the knife next below, and these two quantities fall into the material from the third table, and so on, in case three or more tables are used.

The spouts which feed the storage cylinders may be so arranged that the revolution of the cylinder automatically keeps the cylinder full, the material itself preventing more issuing from the spout than is necessary to maintain a constant level in the cylinder.

Hoppers may also be employed, into which the material can be dumped from wheelbarrows, fed with shovels, or drawn intermittently from a spout at comparatively irregular intervals, the only attention required being to keep the cylinders reasonably full. The volume may be allowed to vary 50% without interfering with the accuracy of the quantity diverted by the knife.

With very finely divided powdered material, which flows very freely, it may be necessary to place a special mechanism in the top of the storage cylinders to regulate the pressure from the contents of a large bin so that it will not force the material to flow with two great a difference of velocity, these finely powdered materials being prone to stick in the bin, and when once in motion to have almost the mobility of water.

These machines may be used for the measuring and mixing of various chemicals; measuring and mixing of dry colors; for mixing of glass batch; for the proportioning of ingredients for the manufacture of special plasters; also of materials for making sand-lime brick; the blending of coffees; the measuring and mixing of flour, sugar, etc., in bakeries and confectionery establishments; for the combining of ingredients in fertilizers, and for a variety of chemical and industrial processes in which accuracy of measuring and mixing and reduction of labor, and especially of skilled labor, is desirable.

As a feeding mechanism, in continuous furnace processes for mills, or crushers, requiring regular feeds, and especially for the rotary kilns used in cement making, these machines have been found to be especially well adapted, and to materially increase the efficiency of the mechanism on account of the greater regularity of the operation.

One adaptation, which gives promise of great use in the industrial arts, is the proportioning of the cement, sand and stone, with the addition of the necessary water, in the manufacture of concrete. The strength of concrete depends largely on the perfect coating of the fine sand with the proper quantity of cement, and the proper filling of the voids between the crushed stone. If the proportions of the ingredients vary considerably some parts of the structure will be weak, and to guard against this weakness larger quantities of cement are necessary than would be the case if absolute accuracy of proportions was obtained.

The usual methods of proportioning the materials in concrete mixing are very crude, and engineers are beginning to realize that for the important work now being done with reinforced concrete, greater accuracy is necessary. The method of measuring the ingredients in wheelbarrows, or by means of shovels in the hands of the ordinary laboring help, is very unsatisfactory, and the effort to make up for this deficiency, by using machine mixers, does not entirely remedy the trouble.

Fig. 7 shows a measuring machine, adapted to concrete mixing, which has been very successful. It is intended for a semi-portable machine, having a capacity of 50 cu. yds. of concrete per hour, the materials being fed from temporary stationary hoppers supplied with ordinary elevating mechanisms, and delivered by the measuring machine through a double spray of water into a short interrupted screw, so that the concrete is delivered in a continuous stream accurately proportioned and thoroughly incorporated with the water. With this machine about 10 HP. is required for measuring and mixing at the rate of 50 cu. yds. per hour, and as small a quantity as a cubic foot can be made with the same accuracy as a much larger quantity.

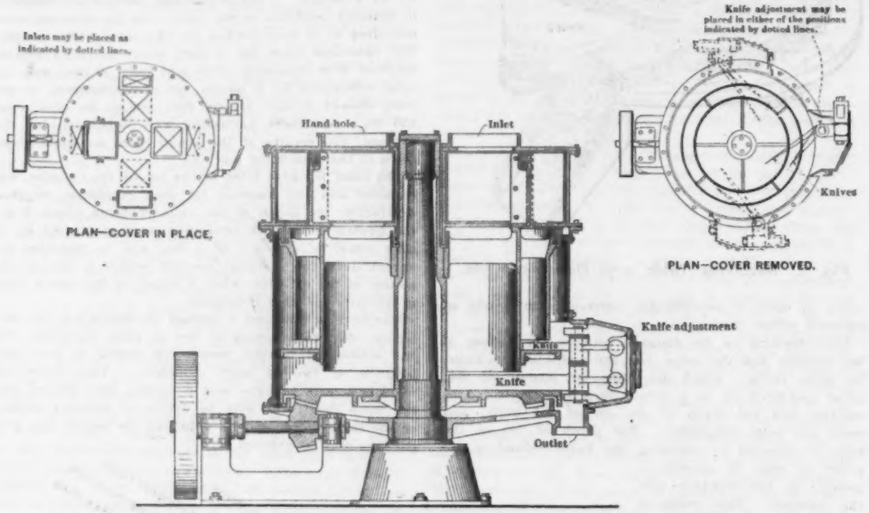

FIG. 6. 36-IN. TRUMP DOUBLE-MEASURING MACHINE FOR FINE MATERIALS.

The diverting knives of the measuring machine can be quickly changed to suit the proportions required in the concrete, and are provided with a locking arrangement so that they can be set by the superintendent and not changed except by his direction.

These machines may be driven by a motor or engine and boiler, and the interrupted screw mixer has vertical and horizontal movements, which are useful in delivering to wheelbarrows, into excavations, or onto the street level in street paving work.

The great saving effected by the accuracy and continuity maintained by these machines have been proven in actual practice, and the accuracy demonstrated by use in actual construction. The only limit in speed is the ability to get material into them fast enough, and as only the interrupted screw conveyor contains any mixed concrete no cleaning is required, and the machine can be stopped and started with little delay.

The cost of making concrete, where the materials were furnished near the job, at the prices mentioned below, and the concrete mixed by hand, has been found to average $5 per cu. yd.

No. 1 Concrete Experiment.—A concrete mixer was installed in a central position, where the stone, cement and sand could be elevated into hoppers by means of a system of buckets elevated on an elevator and pushed by hand at both the bottom and the top, the labor including shoveling the sand and stone into the buckets and emptying cement from the bags. The cost of this concrete was as follows:

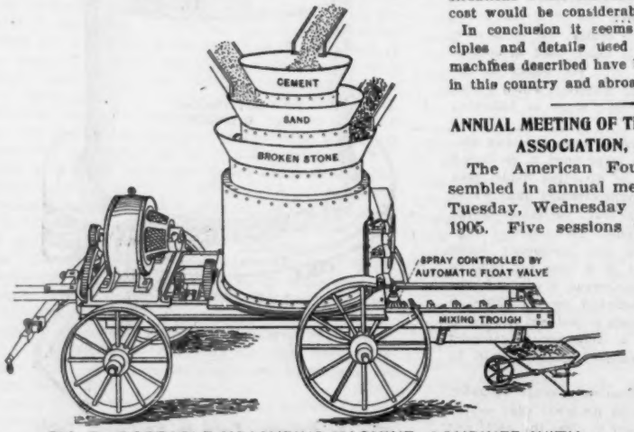

FIG. 7. PORTABLE MEASURING MACHINE COMBINED WITH CONCRETE MIXER.

1 cubic yard of concrete, with a 1:3:5 mixtur... 3,800 lbs., and contains as follows:

4.5 cu. ft. or 1¼ bbls. of cement @ $1.1... per bbl.	
13.5 cu. ft. of sand	
22.5 " " " spalls, 1,975 lbs. @ $0.35 p... net ton	
For hauling sand, then elevating and placing i... hopper	
For hauling cement, then elevating and placing... in hopper	
Cost of mixing 50 yds. per day, labor @ $.15 per hour	
Current and motors	
Repairs—Average for six months	
Cost per cu. yd. loaded into wagons	
Cost of making concrete exclusive of material	

The concrete machine running with the table ma... revolutions per minute, has a capacity of 50 cu. y... hour.

The above figures for labor are higher than they ... be if more concrete had been made, only 50 cu. yds. ... ing the amount required per day.

The machine was operated by making two or ... cubic yards at a time, and then stopping until mor... crete was required.

No. 2 Concrete Experiment.—Foundations of a ... building, the concrete being hauled in carts and d... into trenches.

Cost of concrete loaded into wagons (as above given)	= $...
Hauling from mixer to job	= ...
Putting in place	= ...
Total cost per cubic yard in place	= $2.92

In the above case the concrete was made as fast as ... carts could haul it 500 ft.

No. 3 Concrete Experiment.—Cost of machine ... floor, having 8-in. thickness of concrete, left with a rough surface.

Cost of concrete loaded into wagons	= $2.45
Hauling from mixer to job	= .75
Putting in place	= .86
Total cost per cubic yard in place	= $3.185

No. 4 Concrete Experiment.—Heavy Foundations.

Concrete put into wheelbarrows and wheeled on plank runways about 150 ft.

Cost of concrete loaded into wheelbarrows	= $2.45
Wheeling 150 feet and putting in place	= .73
Total cost per cubic yard	= $3.18

No. 5 Concrete Experiment.—Heavy concrete retaining walls, and concreting around a series of large pipes in a trench, hauling concrete 2,200 feet on bad roads, and wheeling from where wagons were dumped and putting in place.

Cost of concrete loaded into wagons	= $2.45
Hauling 2,200 feet on bad roads	= .26
Wheeling from wagons, dumping and putting in place	= .22
Total cost per cubic yard	= $2.93

The superintendent of the plant in charge of this work reports that the concrete mixer has been in use about six months, and they find it is a great labor saver. The concrete is well made, both as to proportion and mixing, and careful checking of the amount of cement, sand and spalls used and fed to the machine shows that the machine is measuring the quantities accurately. It will be noted that the cost of making the concrete, exclusive of the materials, is only 12 cts. per cu. yd. In other situations where the material is more easily handled this cost would be considerably reduced.

In conclusion it seems proper to state that the principles and details used in the measuring and mixing machines described have been made the subject of patents in this country and abroad.

ANNUAL MEETING OF THE AMERICAN FOUNDRYMEN'S ASSOCIATION, AT NEW YORK, N. Y.

The American Foundrymen's Association assembled in annual meeting in New York City on Tuesday, Wednesday and Thursday, June 6 to 8, 1905. Five sessions were held, three at Grand Central Palace and two at Columbia University. The entire meeting was given closely to business; there was no special or social outing feature, except a visit to the works of the International Steam Pump Co. at Harrison, N. J., on the afternoon of the last day.

The work of the meeting comprised, besides the election of officers and other routine business, consideration of some twenty papers. There were over 200 in attendance at the meeting, and the average number present at the individual sessions was close to 100. While this speaks for

interest in the technical program, there was really no discussion of the papers. The list of titles was printed in advance in the column of Engineering Societies, in our issue of May 25, 1905. Many of the papers there noted, however, were not presented or else were read by title. The papers, "American Molding Sands," by Prof. J. Ries (Ithaca, N. Y.), and "Properties and Analysis of Foundry Facings," by W. G. Scott (Racine, Wis.) were among those not presented.

The more interesting papers of those presented are very briefly summarized in the following:

"Notes on Some Retort-Coke Melting Ratios," by Mr. C. M. Schwerin (Milwaukee, Wis.), gave the melting results of seven heats run in different foundries for demonstrating retort-coke. The ratios obtained are by no means phenomenal, but are given merely as a matter of record. The writer gives also some general discussion of factors affecting coke consumption, and expresses the view that "coke is one of the most expensive things to economize on that there is about a foundry." The melting records given vary from a coke: iron ratio of 1:15.3 (excluding bed; or 1:10.2 including bed) to a ratio of 1:11.3 (1:8.1 including bed). The blast pressure varied from 7 to 10½ oz.

Melting records and blower performance were dealt with in a paper by W. J. Keep (Detroit, Mich.), on "Blowers, Piping and Cupolas at the plant of the Michigan Stove Co." At this plant there are three cupolas, 53, 60 and 68 ins. diameter, supplied by a single positive-pressure blower. The 60-in. cupola is nearly 400 ft. from the blower. The blower is operated at 150 r. p. m., and gives 18 oz. pressure; a relief valve at the blower is set at 18 oz., so that this pressure shall not be exceeded. The three cupolas at full capacity give 32¾ tons of iron per hour, with a coke ratio of 1:9.2 and an air consumption of 22,800 cu. ft. per ton of iron. The author reports that the blower (engine-driven) showed, on test, efficiencies of 90.4% at 13 oz., 92% at 18 oz., and 87.0% at 23 oz. blast pressure. These efficiencies are the quotient of "theoretical horse-power to drive blower" divided by indicated engine-horse-power, so that their meaning is not clear. Moreover, it is stated, "the friction of a short countershaft and belt is included in these figures." The pressure-drop from pipe-friction in the air piping is ½-oz. to the nearest cupola and 1½ oz. to the most distant cupola.

An interesting comparison between centrifugal fans and positive-pressure blowers for supplying cupolas was given by Mr. H. F. Field (Pittsburg, Pa.) in a paper entitled "Fan Blowers vs. Positive-Pressure Blowers." The paper is based on a report made to the Pittsburg Foundrymen's Association several months ago by a committee appointed by that association. Four tests were made with two Sturtevant fans and one Connersville positive-pressure blower, supplying a cupola lined to 54 ins. Blower and fans were driven by electric motor. The electrical power, the speed, and the blast-pressure were observed during four regular cupola heats; two tests were made with the positive-pressure blower and one with each of the fans.

The change of the blast pressure during the individual runs is one of the features of the tests. In the runs with the fans, the pressure rises very slowly as the heat proceeds, until the heat is about two-thirds over, when it again falls slightly but still is somewhat higher at the end than the initial pressure. The total rise from beginning to maximum is 15 to 25%. In the runs with blower, however, the pressure rises very rapidly, from the beginning, and reaches a maximum over twice as great as the initial pressure, when the heat is about two-thirds over, and then falls to a final pressure but little below twice the initial. This means that the blower raises its pressure greatly when the course of the wind becomes obstructed by the action of the cupola, and thus the machine tends to keep up the supply of air. The fan, on the other hand, can raise its pressure only very slightly as the volume of discharge is reduced, so that a very great falling off in the air delivery takes place as the cupola becomes more obstructed. This is reflected in the horse-power readings in the two cases. The fan consumes greatest power at the beginning, and least power when the blast pressure has risen to its maximum; thence to the end of the run the power required by the fan increases again slightly. The blower consumes its least power at the beginning of the run; the power required then rises very rapidly and reaches a maximum over twice as great as the initial, at the same time as the blast pressure reaches its maximum. In the last part of the heat the blower power decreases, ending with about 70% of the maximum. It will be recognized by mechanical engineers that these results are quite natural, being due to the inherent characteristics of the two types of machines.

Assuming that the course of the melting is satisfactory with either machine, it is of interest to know which of the two consumes more energy per ton of iron melted. This is answered by the four tests in question as follows:

	Fan (two tests).	Blower (two tests).
Energy for blast, in horse-power-hours per ton of iron melted..	4.67 3.70	3.84 3.53

In the second test noted for the fan, a special condition existed in the use of very light scrap which was of such shape that it kept the cupola open for freer passage of air. This condition brought the performance of the fan practically to the same point as that of the blowers.

An essential conclusion incidental to the report is that an escape-valve or relief-valve should not be used with positive-pressure blowers, since this destroys their ability to keep the cupola open, and makes the blower equivalent to a fan.

Three papers on Foundry Cost-Keeping and Accounting were presented. A paper entitled "Accounting, an influence toward Lessened Costs and Increased Efficiency," by Mr. K. Falconer (Montreal, P. Q.), advanced some general suggestions as to the value and methods of thorough cost-keeping and accounting. Mr. R. W. McDowell (Uniontown, Pa.), in a paper on "Cost-Keeping for the Foundry," described in some detail a system for recording foundry operations. Specimens of the stationery forms used in this system illustrated the paper. The third paper, "Production Costs," by Mr. E. M. Taylor (Boston, Mass.), constituted a detail study of the factors that compose foundry costs, and how they should be provided for in any cost-keeping system. No particular system was described, but a clear statement of the requirements to be met was given.

A number of papers dealing with details of foundry practice or manipulation may be mentioned here. Mr. J. A. Murphy (Franklin, Pa.), in a paper entitled "A Modern Method of Venting Cores," enlarged on the advantages gained by the use of pressed wires of a special wax composition, for venting cores. A machine for making such wax wires very cheaply is in successful use in the core-room of the air-compressor works of the Chicago Pneumatic Tool Co. at Franklin, Pa. Cores of any degree of intricacy may be perfectly and easily vented by the use of the wax wires, it is stated. Mr. E. B. Gilmour (Peoria, Ill.) read a paper on "The Use of Plaster-of-Paris in the Foundry," in which he described the use of molds of plaster-of-paris, cast in sand molds from the original pattern, for casting drop-hammer dies in which to straighten malleable castings which had become warped in annealing. Mr. A. M. Loudon (Elmira, N. Y.), in a paper on "A Simple and Economical Method of Molding Propeller Wheels," described the method of molding used in the foundry of Thos. Sherriff at Milwaukee, Wis. The molds are made by direct molding from a blade pattern, separately for the several blades, with a section of the hub attached; the molds are then joined up on the floor, being set on a level ring bedded in the floor, and lined to each other by plumbing the vertical joint faces of the hub. Three papers containing suggestions on details of foundry practice were, "Notes on Pipe Foundries, with Suggestions on Metal Mixers for Foundry Purposes," by J. B. Nau (New York, N. Y.); "Some Thoughts on American Foundry Practice," by J. D. Burns (Plainfield, N. J.); and "Practical Brass Founding Flasks," by Chas. Vickers (Milwaukee, Wis.) The use of cupola shot or bottom iron in charging was discussed by Mr. W. W. Sly (Cleveland, O.) in a paper entitled "Shot Iron." A set of analyses of bottom shot, sprue iron, and the metal of a burnt grate-bar was given by the author, which may be of interest here. The author believed that the burnt grate-bar metal should show about the same composition as shot iron, but this was not borne out by the analyses:

	Grate-bar. Burnt End.	Grate-bar. Unburnt End.	Shot Iron. (Bottom.)	Sprues.
Si.....	2.23%	2.60%	1.90%	1.88%
S.....	0.23	0.11	0.08	0.07
P.....	0.84	0.82	0.68	0.50
Mn.....	0.41	0.42	0.80	0.80
Combined Carbon...	0.36	0.07	0.08	0.56
Graphitic Carbon...	1.88	3.18	3.50	2.64

The author reported that he had obtained satisfactory castings from a charge composed wholly of shot iron, and another had made excellent stove-plate from a charge containing 30% shot.

Three papers were presented on the use of Thermite, one paper, "Alumino-thermics," by W. M. Carr (New York), being a demonstration of the material and its use in welding and the like, while the other two, "The Use of Thermite in a Railroad Shop," by J. F. Webb (Elkhart, Ind.), and "The Repair of Driving-wheels by Thermite," by G. N. Prentiss (Milwaukee, Wis.), described the repair of broken castings by means of thermite. It was reported by Mr. Webb that a broken locomotive frame was in one instance repaired in about 20 hours, counting from the time the engine came into the shop until the time it left to take out a train.

Mr. H. M. Lane (Cleveland, O.) presented a paper on "Care and Storage of Patterns," accompanied by a good series of views showing the pattern-storage rooms or buildings in different large shops. The paper itself mentioned briefly the various considerations affecting the difficult and troublesome problem of pattern storage, and outlined various means for meeting them. The large reliance of the paper on its illustrations precludes any more detailed abstract here.

The labor problem (using this term in a very broad sense) was concerned in the three following papers: "Making a Molder," by H. M. Lane (Cleveland, O.); "Better Conditions in the Pattern Shop, an Experiment that Succeeded," by J. L. Gard (Denver, Colo.); and "A Practical Foundry School," by W. C. Bruce (Cleveland, O.) Mr. Lane outlined a very large scheme for a machine-building enterprise which should be primarily a training school for molders, pattern-makers and machinists, but should also operate commercially. The scheme is excellently developed, but does not seem to promise early realization. Mr. Bruce actually proposes to establish a foundry which shall be a molders' school, and solicits co-operation in the enterprise.

The paper of Mr. Gard described a very interesting experiment in a pattern-shop: reducing the working-day from nine to eight hours, with the proviso that all errors or defects made or caused by the workman shall be made up *outside* of the eight hours. The plan evidently requires mutual fairness and harmonious feeling, besides several other things which are not usually thought obtainable. Yet the author reports that the experiment, after more than a year's trial, is a success.

The association's Committee on Standard Methods of Determining the Constituents of Cast Iron submitted a report recommending a standard method of determining silicon. This recommendation, which was adopted, is as follows:

> The following is the method which your committee recommends to be the standard of the association for the determination of silicon in Pig Iron and Cast Iron:
>
> Weigh one gram of sample, add 30 c. c. nitric acid (1.13 sp. gr.); then 5 c. c. sulphuric acid (conc.) Evaporate on hot plate until all fumes are driven off. Take up in water and boil until all ferrous sulphate is dissolved. Filter on an ashless filter, with or without suction pump, using a cone. Wash once with hot water, once with hydrochloric acid, and three or four times with hot water. Ignite, weigh, and evaporate with a few drops of sulphuric acid and 4 or 5 c. c. of hydrofluoric acid. Ignite slowly and weigh. Multiply the difference in weight by .4702.

A further matter of standardization was brought up by a paper on "Foundry and Pattern-Shop Standards," by W. H. Parry (Brooklyn, N. Y.) The author urged that there is no reason why such details as length and taper of core-prints, diameter of loam-spindles, sizes of snap-flasks and molding-machine flasks, should vary

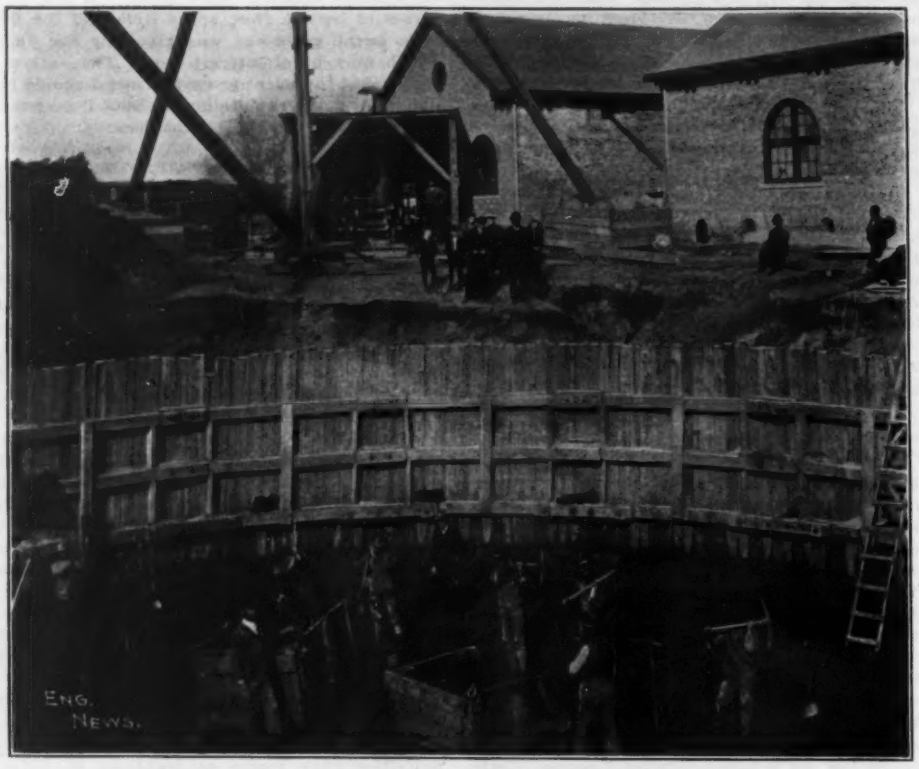

FIG. 1. RING-BRACED SHEET PILING USED IN CONSTRUCTING A WATER-WORKS RESERVOIR AT KINSTON, N. C.

from foundry to foundry. After the reading of this paper the association resolved to appoint two committees, one to consider standards for foundry and pattern-shop practice (exclusive of flask sizes), the other to consider the question of standards for sizes of foundry flasks. The latter committee will deal mainly with machine-flasks and snaps.

A concise statement of the effects of manganese added to cast iron low in silicon was given by H. C. Loudenbeck (Wilmerding, Pa.) in a paper entitled "The Effect of Manganese in Low-Silicon Cast-Iron." A series of eight sets of comparison analyses and strength tests was presented, showing the properties of low-silicon metal before and after adding manganese in various percentages.

An excellent paper on the metallurgical side of foundry work was presented by Mr. P. Longmuir (Sheffield, England), through Dr. Scholl, of Philadelphia, Pa.; "The Variation of the Properties of Alloys." The paper records a large and careful series of tests to determine the influence of casting temperature on the strength and ductility of brasses and similar alloys. By means of thermocouples inserted directly in the molds, the temperature of the metal while being cast was accurately measured. The tests showed that in all cases the strength and ductility were far the highest when the metal was cast at a moderate or "fair" temperature; when cast at higher or lower temperature both strength and ductility were much lower. The chemical analyses in all cases showed exactly the same composition for all bars cast from a single ladle, although the first bars were cast very hot while the last were cast when the brass was quite dull; this shows that there is no burning-out of zinc during the process of pouring. Microphotographs of the sections, however, revealed the cause of the difference in strength, by showing that the finest and best interlocked grain resulted when the casting temperature was "fair." The same results obtained for brass were found to hold, in different degree, with copper, Muntz metal, gun metal, lead and zinc. Further, no form of heat-treatment was found which would restore, to a bar cast too hot or too cold, the lost strength or ductility.

A subject related to the interests of civil engineers as well as foundrymen was treated by J. S. Robeson (Camden, N. J.) in a paper on "Core Sands." The paper recorded a series of experiments on the influence of the sand itself, apart from the influence of the binder, in making a core strong or weak. Various core sands were mixed with a fixed percentage of water and a fixed percentage of one binder ("Gluetrin"), and were molded into 1-in. round covers, baked and tested for transverse strength on supports 8 ins. apart. The strengths varied from ¼ lb. to 6½ lbs. Microscopic study of the sands was also made, revealing the different size of grains and the different proportion of various-sized grains in the sand, as also the amount of clayey-matter present. It was clearly shown that a thorough

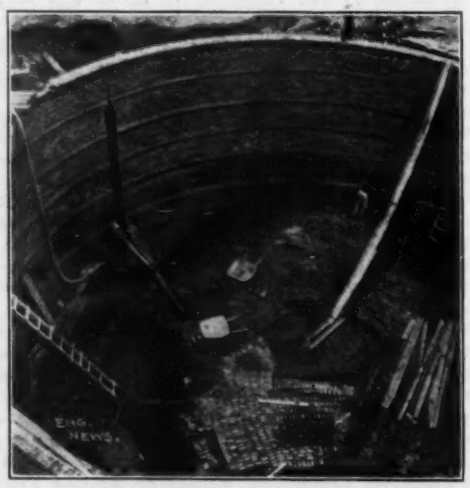

Fig. 2. Completing the Brick Lining in the Kinston Reservoir.

(The vertical pipe at the left is one of the artesian wells which supply the reservoir.)

mixture of various sizes of grain, with a certain amount of clayey matter (but not too much) gave the highest strength. In some cases a mixture of two sands, one too lean the other too rich in loam, gave a sand of higher strength than either of the components individually.

The association elected Mr. Thos. D. West (Cleveland, O.) as president for the coming year, to succeed Mr. C. J. Wolff (Chicago, Ill.) Mr. R. Moldenke (Watchung, N. J.) was re-elected as secretary. The meeting voted to reduce the annual dues of members to $5, in place of the former dues of $5 for members of local associations and $10 for all others. The next annual meeting will probably be held at Cleveland, O.

RING-BRACED SHEET PILING FOR RESERVOIR CONSTRUCTION, KINSTON, N. C.

By George A. Rogers.*

Ring-bracing for holding sheet-piling in place while building a circular reservoir has recently been employed in two places in the South. In the latest instance the reservoir formed a part of the new artesian water supply of Kinston, N. C., and was completed on Feb. 1, 1905. The reservoir has an internal diameter of 60 ft., is 20 ft. in total depth and has a water depth of 15 ft. and a capacity of 350,000 gallons. About 200,000 brick were used in lining its sides and bottom. The side walls are 12 ins. thick at the top and 20 ins. at the bottom, and the bottom lining is 6 ins., or three brick, flatwise, thick.

For the first 5 ft. of excavation drag scrapers were used. Below that a Lidgerwood double drum hoisting engine, a derrick with a 10 × 10-in. mast and a 55-ft. boom, and yard buckets were employed. The dirt from the bucket dump was hauled by drag scrapers and carts, and used to level up the grounds. Below the 5-ft. level the sandy material was so saturated with water that it was literally running sand. The sheet piling used to hold this material in place was driven down, as the excavation progressed, to the marl below which the excavation extended for 1½ ft. The ring of sheeting had a diameter 10 ft. greater than that of the exterior of the reservoir wall. This gave sufficient room between the wall and the sheeting for a ditch to carry to a sump the water which came under the sheeting. A pulsometer pump running day and night removed the water at the rate of 450 gallons a minute.

The rangers or horizontal timbers (see Fig. 1) used for the ring-bracing were 8 × 8 ins. × 12 ft., mitered at the ends, requiring 18 for the 70-ft. circle. As can be understood, in this style of bracing it is necessary to keep the rings level. This was effected, and at the same time the rings were strengthened, by the posts shown in the view, which were 8 × 8 ins. × 4 ft. long, and were securely bolted to the rings.

The sheeting was 2 × 8 ins. × 18 ft., dressed on three sides. Better results would be given by tongued and grooved material, but this would require 3-in. stuff.

The lumber bill for this job was only $100, pine at $10 and $12 per 1,000 ft. being used. The labor on the ring-bracing, including mitering the rangers, boring the holes for bolts and assembling the rings, was all done in three days by two carpenters at $2.50 and four helpers at $1 per day of 12 hours. The iron work cost about $30.

Fig. 2 shows the reservoir when the brick lining was nearly completed.

In the work described Mr. J. L. Ludlow, M. Am. Soc. C. E., of Winston, N. C., was consulting engineer, and Mr. Clinton C. Holroyd, of Boston, Mass., was resident engineer. The West Construction Co., of Chattanooga, was the contractor. The writer served as superintendent of construction for the latter, and in conclusion would state that the ring-bracing proved very satisfactory, and, for excavation of this kind, is the cheapest bracing with which he has ever had experience, besides leaving the whole interior of the excavation entirely free.

BIDS FOR THE LAGUNA DAM and Sluiceways, to be constructed by the U. S. Reclamation Service near Yuma, Ariz., were opened for the second time on June 5. The lowest bid was $797,650, made by J. G. White & Co., 49 Exchange Place, New York City. This was $37,000 lower than the lowest regular bid received on March 15, 1905. After the last-named date five bids, delayed in the mails by railway washouts, were received, and, on advice of the U. S. Attorney-General, rejected. It was decided to readvertise. The proposed dam was illustrated and described in our issue of Feb. 9, 1905. The dam is of great interest, as it is to be a rock-fill structure, on sand and gravel, with two concrete cut-off walls, below one of which there will be sheet-piling. The bids received on March 15 were published on p. 130 of our Construction News Supplement for April 6, 1905, and the latest bids are given in that part of this issue. Mr. J. B. Lippincott, M. Am. Soc. C. E., of Los Angeles, Cal., is Supervising Engineer, and Mr. Homer Hamlin, M. Am. Soc. C. E., of Yuma, Ariz., is Engineer in Charge of the Yuma project.

*Bellmore, Long Island, N. Y.

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Is the mechanical stoker for boiler furnaces a success, mechanically and commercially? This question came forward in the discussion last week at the Scranton meeting of the American Society of Mechanical Engineers, when Prof. Benjamin's paper on "Smoke Prevention" was presented and the opinions expressed, it must be said, were not very favorable to the mechanical stoker. We do not mean to say that mechanical stokers are a failure, by any means. Undoubtedly a great number of boiler plants equipped with mechanical stokers are in regular operation, and in a considerable percentage the results in the way of smoke prevention, fuel economy, and general commercial results are such as to fully satisfy the owners and managers. If this were not the case, the installation of mechanical stokers would soon cease.

There are other plants, however, where, as one speaker in the discussion stated, the mechanical stoker shows no better results in any way than hand firing, and the labor saved does no more than pay for the interest on and repairs to the stoker plant. Can such plants be called successful? We doubt it. Unless a labor-saving machine can pay something more than mere interest on its cost, it is seldom worth while to install it. The average manufacturing concern must earn more than mere interest on its invested capital or it might as well go out of business and loan its capital to others, as a safer and equally profitable way of employing it.

There is still a third class of automatic stoker plants where the stoker undeniably "falls down." The fault may be laid on the coal, which, perhaps, clinkers badly, or has a large percentage of fine dust, or a large proportion of dirt or stone, and the stoker manufacturer defends his machine on the plea that it is made to fire coal and not slack or dirt. This plea, however, does not go far with the steam user. What he wants is to burn the fuel which will give him the most steam for a dollar; and if the automatic stoker cannot humor the idiosyncrasies of bad fuel like the human fireman, then so much the worse for the automatic stoker.

These are, as we understand them, substantially the facts of the case regarding the use of automatic stokers. They are sometimes a success, sometimes a dismal failure, and in perhaps the majority of cases, the balance is substantially even between automatic stoking and hand firing.

In the light of these facts the problem before an engineer responsible for the design of a power plant is a very troublesome one. The owner may very likely consider that automatic stoking is essential to an up-to-date power plant of large size; and the present coal supply may indicate that automatic stokers would show good results. Yet at some future date after the plant is installed, a change in market conditions may make a change in fuel imperative and the condemnation that may then fall on the automatic stokers and the engineer who ordered them installed will be complete.

At the Scranton meeting it was generally conceded that there was no reason for using automatic stokers in any power plant of moderate size, so that their use is limited any way to large plants. And in such plants caution regarding their installation would seem to be indicated. If the engineer is familiar enough with the different makes and their results with different kinds of coal, he can easily decide; but few engineers have such knowledge. In its absence the wise course would appear to be the requirement from the stoker builders of a guarantee of definite results in regular service, rather than in contract trials with selected coal and operators, or else the installation of a single boiler and equipment to show what results can be obtained with the coal to be used before the complete equipment is ordered.

Attention is called to an article in this issue by Mr. E. N. Trump, describing a simple device for automatically measuring and discharging the ingredients of concrete into a mixer. One of the features of this machine that will appeal to the contractor is the absence of large storage bins and the force of men necessary to feed the materials from the bins into the mixer. We would suggest that by providing stock-piles and a small clam-shell bucket for feeding the materials from the piles to the bucket elevators that deliver into the measuring device, it will be possible to mix concrete at an even lower cost than that given in the article. In this connection also, it may be well to point out that one of the main objections to the continuous concrete mixer has been that it requires the greatest care in feeding the materials into it. There are enough examples of excellent concrete made with continuous mixers to prove that good concrete can be made with them. The trouble in the past, where there has been trouble, has been due to carelessness in feeding the ingredients into the mixer. The device invented by Mr. Trump merits praise for its simplicity and effectiveness not only as a machine for measuring concrete ingredients, but it apparently has a wide field of usefulness wherever broken ore, stone, or granular materials generally are to be measured. It appears, from tests given by him, that the accuracy of the measuring machine is practically as great as may be obtained by weighing. The machine is certainly well worthy of investigation.

The notable lack of technical qualifications in the members appointed to make up the New York City Water Commission and the New York State Water Commission and Gas and Electricity Commission, cannot fail to impress engineers who examine the list of appointees named in our Personal columns last week and this. The gratifying but single exception is the name of Dr. Ernst J. Lederle, for many years chemist in the New York City Health Department and Commissioner of Health during Mayor Low's administration. At least one man of similar relative qualifications might advantageously have been appointed on the other two commissions. In saying this we cast no reflections on the other appointees, particularly not upon the members of the city water commission; but obviously the lack of experience in connection with the conduct of any sort of engineering works on the part of the various commissioners, with the exception noted, makes it even more necessary that they exercise the greatest care in the selection of strong technical staffs.

The London "Times" hits the nail, indeed several nails, on the head in some recent comments on "American Refuse-Destructor Practice." It says:

> Whilst the refuse-destructor has attained a recognized position in this country, and its value is acknowledged on all hands from an economical, as well as a hygienic point of view, the situation regarding similar appliances in the United States is in singular contrast to the progress made in this country in the utilization of towns' refuse. For this there appear to be several reasons, none of which convey any reflection on the ability of American engineers to place this branch of engineering on the high level associated with the general industry in America. The chief of the causes assigned for the backwardness in this respect is concerned with the politics of the United States municipalities, by which municipal engineering and sanitation are controlled to a large extent by considerations which have no reference to their individual advancement and well-being. Contracts relating to such engineering works are found extremely difficult to obtain on any satisfactory basis, and still more difficult to successfully carry out, with the result, as stated, that an important branch of engineering practice in the United States is, and seems likely to remain, many years behind that of Europe.

This is all very true so far as political influence and mismanagement is concerned, and it is also quite true that American engineers are not responsible for the situation. The "Times" confines its remarks to refuse destructors, or what we here term garbage furnaces, either being ignorant of or else ignoring the fact that our garbage reduction systems have been carried to quite a high stage of mechanical development, and that the garbage of nearly all our large cities is utilized for the production of grease and a fertilizing base, and in the process of treatment is rendered innocuous. Our reduction plants, however, have been the cause of more, or if not more then worse, municipal scandals than our garbage furnaces, largely because the interests involved have been greater. Both the collection and final disposal of municipal refuse in the United States are in sad need of being put on a businesslike basis, and of being freed from political corruption. This done, necessary engineering improvements will come rapidly.

THE CAUSE OF HIGH TEMPERATURES IN THE NEW YORK SUBWAY.

It was expected by the patrons of the New York Subway that it would be warm in winter and cool in summer. The air of the subway has been decidedly warmer than the air of the streets during the cold months that have just passed, but now that warmer weather has come the subway air refuses to conform to expectations and predictions—it still remains warmer than the air above ground. What is the reason? Why is the subway not like a cellar, or a cave, or a shallow mine? The answer to this question is simple though not self-evident. In the subway we have a great number of electrically driven trains almost constantly in motion, which is equivalent to saying that they are consuming great quantities of power. But where does this power go? It is not destroyed, therefore this visible manifestation of power is converted into the invisible manifestation which we call heat. The electric motors must overcome the journal friction of the axles, the rolling friction of the wheels, the air friction at the heads and sides of the cars, and the inertia of the train at the time of starting. With the exception of the force used in overcoming inertia, the power of the motors is expended in overcoming friction, or in other words is converted into heat. And, in the last analysis, even the force used to overcome the inertia of the trains is converted into heat, for when the brakes are set to retard the train the heat developed at the surfaces of contact between the brake-shoes and the tires is equivalent to the electric energy originally expended in overcoming inertia. Even the work done by the motors working against the resistance of gravity on an ascending grade is converted into heat; for, in a round trip of the train, the power stored in ascending must be given back in descending, and when given back it acts in overcoming the frictional resistances above cited.

The electricity that is lost in transmission through the third rail is a frictional loss, hence it is converted into heat. The multitude of incandescent lamps both in the cars and along the interior of the subway are likewise heat generators. So too are the people who ride on the trains, as well as those who work in the subway. In a word, there is a constant and large conversion of fuel into heat.

If we assume that the generators in the subway power-house convert into current 10% of the heat energy of the fuel burned under the boilers, then for every 500 tons of coal burned under the boilers which develop steam to run the dynamos,

there are 50 tons whose full heat value is discharged as electricity into the subway; and the heat of these 50 tons is given off in the subway just as surely as if 50 tons of coal were burned in bonfires along the subway tracks.

With a view to determining the actual difference of temperature between the outside air and the air in the subway, a member of the editorial staff of this journal made a series of observations on two days, June 9 and 10, with the following results. On the morning of June 9, at 10 a. m., it was found that when the outside air was 72° at the Brooklyn Bridge Station, the air in the subway between the Bridge Station and 14th St. was 78°. At 4:30 P. M., the same day, when the outside air near the Bridge Station was 76°, air in the subway was quite uniformly 80° up as far as 103d St., on the Broadway branch, above which station the temperature fell off rapidly, due to the opening to outer air where the elevated section of the road begins.

On June 10, at 9 A. M., the outside air at 145th St., on the Broadway section, was 70°; and inside the station it was 75°. The air in the moving train was 76° at 110th St., and 78° at 42d St. The thermometer, when read five minutes later on the station platform at 42 St., was 76½°. Then it was taken into the street, and after ten minutes it registered 73°, showing a difference of 5° between the subway air and the surface air. Upon returning to the station platform, the thermometer rose to 76°; and it registered 79° in the train as far as the Bridge Station. On the station platform it rose to 80°. When taken to the street above, and read ten minutes later, the thermometer registered 75°. These records prove conclusively that the subway air is at present from 4° to 6° hotter than the surface air above. They also show that the air on the station platforms may be 1° to 2° hotter or cooler than it is between stations, depending upon local conditions of ventilation and upon the amount of heat entering through the glass sidewalks overhead. Since the windows of the cars were wide open, the temperature in the cars was essentially the same as the temperature in the subway.

Now, let us estimate the amount of heat developed in the subway by the electricity and distribute this heat over an amount of air sufficient to raise its temperature 6°.

We are reliably informed that the electricity required to operate and light the subway amounts to an average of about 380,000 KW. hours per day of 24 hours. Each kilowatt hour is equivalent to slightly more than 3,400 heat units; hence we have $380{,}000 \times 3{,}400 = 1{,}292{,}000{,}000$ heat units developed daily by the generators in the subway power-house. Allowing for the loss of energy in the transformers and the line losses occurring before the current enters the subway, still leaves more than a billion heat units per 24 hours actually delivered into the subway and effective in heating the subway air. Assuming that the subway has an average interior cross-section of 750 sq. ft., including stations, and a length of 53,000 ft., we have $53{,}000 \times 750 = 39{,}750{,}000$ cu. ft. of air in the subway. Since it takes 13 cu. ft. of air to weigh 1 lb., there are practically 3,000,000 lbs. of air in the subway. The specific heat of air is practically ¼, hence to raise this air 1° in temperature requires $\frac{1}{4} \times 3{,}000{,}000 = 750{,}000$ heat units. To raise it 6°, requires $6 \times 750{,}000 = 4{,}500{,}000$ heat units. But we have shown that there are more than 1,000,000,000 heat units poured into the subway every 24 hours by the electric current. Possibly 10% of this may be lost by conduction through the roof and sides of the subway, still leaving 900,000,000 heat units, which is sufficient to heat the whole of the subway air 200 times a day to a temperature 6° higher than the outside temperature; for $900{,}000{,}000 \div 4{,}500{,}000 = 200$. If this volume of air is to be supplied, the subway air must change 200 times in 24 hours, or practically once every 7 minutes. At first thought it seems incredible that so rapid a change of air can take place, considering the narrowness and infrequency of the exits and entrances. But there are more than 30 stations in the ten miles, and an average of nearly 4 entrances and exits to each station, or 120 openings for ventilation, of which half, or 60, may be assumed as intakes for the outside air. If these intakes average 70 sq. ft. in cross-section, the air will need to pass through them at a velocity of about 10 miles an hour to change the subway air 200 times in 24 hours or once in 7 minutes. Ten miles an hour is called a "brisk wind." While we do not know what the average actual velocity of the air currents is through the intakes and exits, there are certainly many places where the air moves faster than a "brisk wind," although in others it is unquestionably slower.

We have not attempted to split hairs in the foregoing calculations, and have consequently left openings for certain criticisms, such for example as the apparently small heat loss allowed for conduction through the roof and walls of the subway. However, if the reader will apply the formulas and data given in Kent's Mechanical Engineer's Pocketbook, p. 468, and in Carpenter's Heating and Ventilating Buildings, p. 66, it will be found that our allowance for heat loss from this source is sufficient.

We have not taken thermometric readings during the night to arrive at a closely accurate average for the 24 hours, nor have we considered the variations in electric current—all of which would have some bearing upon the problems, if great accuracy were required. Our main objects, however, we believe have been attained, for we have shown why the subway air must always be somewhat hotter than the outside air, and we have indicated how it is possible to approximate the number of times that the air is changed in 24 hours by careful temperature observations. That the entire subway air is actually changed far more frequently than has been hitherto supposed is practically proved by the above discussion. It appears also clear that the subway air is changed far more frequently than is necessary for perfect sanitary requirements, even allowing 3,000 cu. ft. per hour per person. The problem of ventilation of the subway, then, is not a problem of sanitation, but a problem of keeping the subway temperature down to a reasonable limit.

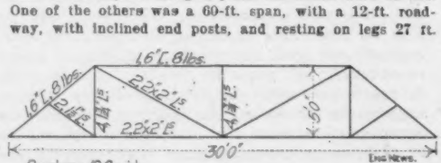
If this problem has been anywhere definitely stated hitherto in engineering literature, we are not aware of the fact. On the contrary, the assumption has invariably been that because the electric motor and the electric light produce no pollution of the air, therefore ventilation of tunnels in which electric motors are used for traction could be ignored.

We believe the computations above show the falsity of this assumption. In previous installations of electric traction underground, the traffic density, weight of trains and size of motors have been small compared with that in the New York subway, and the tunnels themselves have been comparatively short. Thus while there have been well founded complaints of bad ventilation in some of the earlier electric motor operated tunnels, it has remained for the New York subway to demonstrate that the heating effect of the electric power on the subway air is a matter that should be foreseen and considered by the designing engineers.

LETTERS TO THE EDITOR.

Highway Bridge Building in Texas.

Sir: I enclose a diagram of a proposed bridge on which I was asked to bid by a commissioners' court near here. This is one of five bridges, plans for which were on file. One of the others was a 60-ft. span, with a 12-ft. roadway, with inclined end posts, and resting on legs 27 ft.



A Truss for a Texas Highway Bridge.

high, of two 9-in. channels, with one panel of sway bracing. Both piers are in the channel of the stream, and set on concrete pedestals 3 × 3 × 2½ ft. on the mud bottom. No provision is made to counteract longitudinal motion. There is no law here regulating the letting of contracts by commissioners' courts, and it is merely a matter of who can make the lowest figures on the lightest structures, regardless of danger to the public. I would like to have your opinion on the 30-ft. span as to its capacity in a country where traction engines and large herds of cattle have to cross continually.

Yours very truly,

L. S. Leverseder, C. E.

Fort Worth, Texas, May 29, 1905.

("Penny-Wise and Pound Foolish," is a proper comment to make on such a bridge design as that illustrated. It may possibly be that by the use of high unit stresses and low live loads the bridge can be made to appear all right on paper; but not once in a hundred times is such a structure given detail connections which are at all proportionate to the strength of the members themselves. The fact is, as has been before pointed out in these columns, that to pare down sections to save a few pounds of iron in such a bridge as this is the poorest sort of economy. The expense in such a structure is in the design, fabrication and erection, and to actually double the weight of every section of the bridge would increase by only a small percentage the cost of the structure.

Another point which the intelligent commissioners wholly overlook is the influence of design on the life of a structure. If they want a bridge which will require replacing in a dozen years or less this structure will probably fill the bill; but the taxpayers who pay for steel bridges generally suppose that they are to be classed as permanent improvements, and are to last as long at least as a wooden bridge. If a highway bridge is to last, it should be designed with a clear understanding that it must still be safe for travel after years of corrosion have done their work on its members, and after years of motion under loads have done their work upon its joints and connections.—Ed.)

Crown Thickness and Crown Pressure in Masonry Arches.

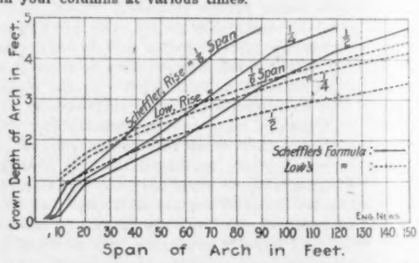
Sir: In your issue of September 15, 1904, on p. 243, I submitted a formula for finding the crown thickness of masonry arches, as follows:

$$d = \text{crown thickness} = \frac{1}{8}\sqrt{(8 - R)\,10 + 2H}$$

in which

S = span of arch, in feet,
R = rise of arch, in feet,
H = depth of surcharge over arch, in feet,
d = thickness of arch at crown, in feet.

This formula met with more or less favor from different writers, whose letters of criticism were published in your columns at various times.



Comparison of Scheffler's and Low's Formulas for Crown Thickness of Masonry Arches, for three Ratios of Span to Rise.

On p. 494, of your issue for May 11, 1905, Mr. C. H. Wallace publishes a formula on this same subject, and gives an example showing its application. In the example referred he assumes the safe pressure in arch ring, in pounds per square foot, as 65,000.

One of the best known German authorities on the subject of theory of arches is Dr. Hermann Scheffler. His theory of Arches, Retaining Walls and Iron Bridges, was published in 1857. On pp. 76-79 of that work he gives a list of 40 well-known arches, giving their dimensions, pressure to which they are subjected, factors of stability, etc. The writer has taken this table, modified it, and has also made some additions to the same. These latter include the depth of keystone as computed by the writer's formula, and also two columns showing, respectively, the actual crown pressure per square foot, and the pressure for depth of keystone as given by the writer's formula.

Trautwine (see p. 923) gives 960 tons per sq. ft. ultimate crushing load for Conshohocken limestone, 840 tons for Hummelstown red sandstone, equivalent to 1,920,000 and 1,680,000 pounds per sq. ft. Referring to the arch No. 26, in the subjoined table, which is the largest semi-circular one given, namely 120 ft. span and 60 ft. rise, and having an actual crown depth of 4.6 ft., the actual crown pressure is only 15,220 lbs., or about

the 1-100 part of the crushing strength. The longest elliptic arch given is No. 39, with a span of a 150 ft. and a rise of 35 ft.; here the actual pressure is 30,600 lbs. per sq. ft., or the 1-60 part of the crushing strength. It will be noted from the table that my formula gives in most instances a somewhat higher unit pressure at crown than the actual.

I have also added a column giving the crown depth as deduced from the table given on p. 81 of Dr. Scheffler's work. This table is based on the assumption that the crown pressure for the small arches is equal to the weight of a stone column 10 ft. high, and for the largest arches to a stone column 200 ft. in height, which is supposed to be the maximum. In other words the crown pressure ranges from 1,500 to 30,000 lbs per sq. ft. It is very evident that Dr. Scheffler's table for finding the depths of arch rings is altogether empirical and made to fit as near as possible the actual depth of arch rings of the 40 arches which he gives as examples.

As a matter of information I have plotted the arch depths for three ratios of span to rise, as given in Dr. Scheffler's work. The lines are shown on the diagram herewith, where I have also shown the lines as derived from my formula. The diagram clearly shows that on long spans my formula gives crown thicknesses lower—but only slightly lower—than Scheffler's formula. For spans of 40 to 70 ft. the two formulas give practically identical results, while for shorter spans my formula even gives the larger thickness of ring.

It seems to me that Mr. Wallace's formula is open to serious criticism on account of basing it on an excessive unit pressure in the arch ring, namely 65,000 lbs. per sq. ft. In the largest arches of the accompanying table the actual crown pressure is considerably less than one-half, in one or two cases only one-third, of the pressure used by Mr. Wallace. In the smaller arches the discrepancy is still more marked, since the actual pressures in the arches as built, range from 2,000 to 15,000 lbs. per sq. ft.

Of course, my formula (as also Dr. Scheffler's), is only empirical, deduced from actual practice in arch construction. Such a formula, being founded on construction that has proved its sufficiency, takes into account all of the various factors which affect the ring thickness, even though the resulting formula may appear irrational in form. Mr. Wallace's formula, on the other hand takes into account only the average unit pressure in the ring section; in consequence, as shown by the table, it gives results which are seriously below the standards set by actual practice. If the arches were built of material having the characteristics of steel, a formula such as Mr. Wallace's might have some value; but for masonry arches, where the actual average crown pressures in practice are shown to vary between 2,000 and 30,000 lbs. per sq. ft., it is certainly without merit.

Moreover, there is a tendency among railway engineers, nowadays, to use even larger depths of keystone than heretofore. Take as example the practice of the Pennsylvania R. R., as instanced by some recent large arches built by Mr. W. H. Brown, Chief Engineer:

Silver Lake Viaduct, Pittsburg, Pa.
100-ft. span, semicircular, 48-in. ring.
80-ft. span, semicircular, 42-in. ring.

Coatesville Arch Bridge.
88-ft. span, semicircular, 45-in. ring.
78-ft. span, semicircular, 42-in. ring.

Rockville Arch Bridge.
70-ft. span, segmental, 42-in. ring.

In view of the matter above presented I still believe that the general form of my formula is all right. With a divisor or 6, instead of 8 as above given, it will closely approximate the crown depths of many modern structures.

Yours truly,
Emile Low, M. Am. Soc. C. E.

Rome, N. Y., June 3, 1905.

THE FORMATION OF ANCHOR ICE, AND PRECISE TEMPERATURE MEASUREMENTS.*

By Dr. Howard T. Barnes.†

My attention was first directed to this very important problem by the Harbor Commissioners of Montreal in 1896. The Chief Engineer of the Harbor Commissioners, Mr. Kennedy, was a member of the Flood Commission to investigate the very serious floods that visited the city of Montreal from time to time, and he was appointed with other gentlemen to go into this question with a view of alleviating the disastrous effects. During the investigation of the Flood Commission efforts were made to study the slush ice, which is called in Canada frazil ice, and to connect the formation of this remarkable ice with the temperature changes in the water. The commission took a series of measurements of the temperature of the water, and they thought they detected small differences of temperature during such times as the ice was most severe. But they were not sure of their results on account of the difficulties encountered in making the measurements. Thus the commission came to McGill for more refined measurements. They wished, if possible, to connect the temperature of the water with the formation of frazil ice.

We devised then an instrument for doing this which depended on the change in the electrical resistance of platinum wire. Such instruments have been made before, and have been exceedingly useful for all classes of temperature measurements; but we devised the most delicate differential thermometer that probably has ever been made. This thermometer had a degree which was 8 ins. long. It was possible to estimate by this means to the ten-thousandth part of a degree.

The varied conditions in which we meet river ice make it almost impossible to establish a definite set of rules by which we can say how much ice will be formed or what the ice will do. The weather itself varies from year to year, and what conditions will hold one year will be entirely different the next. The problem is a problem of heat transmission. The extraction of heat from the water causes ice to form. How is this heat abstracted and how does water gain heat again?

The three recognized methods of transmission of heat are convection, conduction and radiation.

The first method, convection, we may briefly define as the transmission of heat by the movement of matter itself. It depends entirely on the fact that matter when heated expands and becomes less dense. We have one exception to this in water at 4° Cent. At 4° we have the maximum density or the liquid occupying the least volume. Below that point to zero, water expands. Above that point, as high as we can go, water expands; hence we see that in the case of water the process of convection will cause a current of warmer water to rise until we get to 4°, and then the reverse process will take place. Below 4°, as the water becomes cool, the warmer layers sink to the bottom. That has a very important influence, as we shall see presently in ice formation in lakes and quiet water.

I want to dwell for a short time on the physical properties of ice. We know that ice is very plastic; it can be molded into various shapes. We have examples of ice which has been pressed between heavy molds to form perfect spheres; and ice that is pressed in a cylinder may be forced out of a narrow opening. Ice, however, does not exhibit the characteristic properties of viscosity. The phenomena which enables it to give under pressure is probably due to another physical property of ice, namely, regelation. We know that pressure sufficiently great will melt ice; 150 atmospheres pressure will lower the freezing point of water and ice 1° Cent. It does this by squeezing some of the ice back into water; the temperature is lowered by the melting of the ice and the absorption of the heat. Regelation accounts for a great many ice phenomena of nature. A very beautiful example of regelation is Bottomley's experiment. It is a block of ice being cut through by a wire attached to a weight. I dare say many of you have seen the experiment. The pressure of the wire at the point of contact melts the ice. The water runs around the wire, and finds itself freed from the pressure and at a temperature lower than its freezing point; it freezes again above the wire. In this way the wire slowly creeps through the ice, leaving it as strong after the wire passes as it was before. By means of pressure we can freeze blocks of ice together—two pieces of ice brought together and pressed will stick together. A slight film of water is formed on the touching surface and immediately the pressure is relieved the water in contact with the ice surface finds itself below the normal freezing temperature at once solidifies, cementing the two blocks together.

There is another property which ice possesses and which has quite recently been measured. That is, it possesses the power of growing by itself; ice in contact with water exactly at the freezing point apparently goes on growing. You have all observed the beautiful growth of a crystal of alum or a crystal of sugar in a saturated solution of the alum or sugar, and how it gradually increases in size. Apparently ice does the same thing, only very slowly. As I shall explain to you presently water possesses ice in solution. The rate of growth of the ice crystals has been measured. If we allow the natural rate of growth to go on it would form an inch in about two and one half years. So it does not form a very important factor in practical engineering problems. It forms an important factor, however, in this respect, that it helps to cement ice crystals together.

Below 40° Cent. or about 97° F. water commences to form ice; this ice remaining in the solution until the freezing point is reached. The proportion of ice increas-

*From a paper presented at the Scranton meeting of the American Society of Mechanical Engineers.
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CROWN DEPTHS OF SOME REPRESENTATIVE MASONRY ARCHES (SCHEFFLER) AND COMPARISON WITH LOW'S FORMULA.

Name of Bridge or Arch.	Engineer.	Year Built.	Form of Arch.	Span.	Rise.	Ratio Span to Rise.	Depth of Keystone. Actual.	Depth of Keystone. Low.	Depth of Keystone. Scheffler.	Horizontal Thrust at the Crown.	Pressure per sq. ft. at Crown. Actual.	Pressure per sq. ft. at Crown. Low.
1—Common Arch	....	....	Semi-circle	12	6	2	1	.98	.92	11	1,710	1.745
2—Brunoy, over the Hyères	Perronet	1789	Segmental	18	2.5	7.2	2	1.57	1.48	37	2,775	3,535
3—Common arch	.....	....	Segmental	24	6.5	3.7	1.5	1.66	1.53	40	4,000	3,614
4—Niederpleiss, over the Pleiss	.....	....	Segmental	32	9	3.6	1.75	1.90	1.72	61	5,228	4,816
5—Braunschweig, over the Ocker	....	1852	Segmental	37	5	7.4	2	2.24	2.38	112	8,400	7,500
6—Wupperfürth, over the Wupper	.....	....	Segmental	45	11.25	4	2.5	2.30	2.41	114	6,840	7,435
7—Château-Thierry, over the Marne	Perronet	1786	Elliptic	48	16	3	3.5	2.24	2.54	124	5,314	8,303
8—Opladen, over the Wupper	.....	....	Semi-circle	56	28	2	3	2.10	2.60	129	6,450	9,214
9—St. Angelo, at Rome	Messius Rusticus	138	Semi-circle	58	29	2	4.6	2.14	2.82	148	4,826	10,375
10—Moulins, over the Allier	Regemortes	1764	Elliptic	60	20	3	3	2.50	3.13	180	9,000	10,800
11—Pesmes, over the Ougnon	Bertrand	1772	Segmental	43.5	3.8	11.4	3.8	2.50	3.22	190	7,500	11,400
12—Saumur, over the Loire	Voglie	1764	Elliptic	60	20	3	4.5	2.50	3.26	195	6,500	11,700
13—Elberfeld, over the Wupper	.....	....	Segmental	56	9	6.2	2.75	2.72	3.34	204	11,126	11,250
14—Blackfriars, London, over Thames	Mylne	1776	Segmental	72	29	2.2	6.5	2.60	3.36	206	4,753	11,884
15—Ferrato or Cestius, Rome	Cestius Gallus	....	Semi-circle	74	37	2	4	2.40	3.40	212	7,950	13,250
16—Trilport, over the Marne	Perronet	1765	Segmental	72	26	2.8	4.5	2.68	3.50	226	7,533	12,650
17—Fabricius, at Rome	.....	....	Semi-circle	80	40	2	5	2.50	3.65	250	7,500	15,000
18—Tours, over the Loire	Bayeux	1762	Elliptic	75	25	3	3	2.80	3.71	259	12,950	13,375
19—Vieille-Brioude, over the Allier	.....	1753	Elliptic	75	25	3	4.65	2.80	3.81	275	8,871	14,732
20—Nemours, over the Loing	Perronet	1805	Segmental	50	3	16.7	3	2.72	3.84	280	14,000	15,441
21—Blackfriars, London, over Thames	Mylne	1776	Segmental	94	39	2.4	6.5	2.94	4.20	355	8,193	18,112
22—Nogent, over the Seine	Perronet	1769	Elliptic	90	27	3.3	4	3.14	4.28	377	14,138	18,003
23—Orleans, over the Loire	Hupeau & Perronet.	1759	Elliptic	92	25	3.7	4	3.24	4.35	395	14,810	18,287
24—Ponte-Sainte-Maixence, over Oise	Perronet	1784	Segmental	72	6.5	9.6	4.5	3.20	4.48	435	14,500	20,390
25—Orleans, over the Loire	Hupeau & Perronet.	1759	Elliptic	100	28	3.6	4	3.36	4.56	459	17,212	20,491
26—Des Tetes, over the Durance	Henriana	1732	Semi-circle	120	60	2	4.6	3.07	4.58	467	15,220	22,817
27—Mantes, over the Seine	Hupeau & Perronet.	1765	Elliptic	108	33.5	3.2	5	3.42	4.69	508	15,240	22,280
28—Fleischbrücke, at Nurnberg	Carle	1599	Segmental	94	12.4	7.6	3.9	3.58	4.74	531	20,423	22,248
29—Jena, at Paris, over the Seine	Lamandé	1813	Segmental	90	10.6	8.5	4.8	3.53	4.79	550	17,187	23,370
30—Claix, over the Trac	.....	1611	Segmental	140	52	2.7	3	3.71	4.85	585	29,250	25,052
31—Tournon, over the Doubs	.....	1545	Segmental	152	63	2.4	2.7	3.73	4.94	629	34,945	25,295
32—Mantes, over the Seine	Hupeau & Perronet.	1765	Elliptic	120	35	3.4	5	3.65	4.95	632	18,960	25,972
33—Neuilly, over the seine	Perronet	1774	Elliptic	120	30	4	5	3.75	5.02	671	20,130	26,840
34—Pontoise	.....	....	Segmental	90	6.67	13.5	5	3.61	5.05	689	20,670	28,640
35—Over the Taff, England	Edwards	1756	Segmental	140	35	4	3.5	4.06	5.09	715	30,642	26,416
36—Marble arch, Florence	M. Angelo	....	Segmental	134	29	4.6	5.2	4.06	5.18	775	22,356	28,632
37—Vieille-Brioude, over the Allier	Grenier & Estone	1454	Segmental	173	67	2.6	4.14	4.08	5.29	867	31,413	31,875
*38—Schwelm, under the railroad	Maertens	1848	Semi-circle	86	18	2	3	2.43	5.29	868	43,400	53,580
39—Over the Severn, England	Telford	....	Elliptic	150	35	4.3	4.5	4.24	5.34	918	30,600	32,476
40—Neuilly, over the Seine	Perronet	1774	Segmental	122	13.1	9.3	5	4.13	6.50	1,301	39,030	47,250

* Under an embankment 100 ft. high.

ing as the temperature falls, and at the freezing point we have actually a saturated solution of ice and water. It explains to us the maximum density of water and the minimum specific heat.

The curve showing the variation of the specific heat of water drops very rapidly from 0° Cent. and passes through a minimum at 40°. Now that is apparently due to the fact that besides the heat absorbed in the natural expansion of the water we have the heat absorbed in transforming those ice molecules into water molecules. That is, as the temperature rises, the amount of heat that would be absorbed by the ice becomes less and less. At 40° Cent. we have an exact balancing. From 40° upwards we have water existing as a pure liquid.

I think I have taken up the chief points in regard to the physical properties of ice and water, with the exception of the great change in volume that takes place when water freezes, which has such an important influence in river ice formation. There is an increase of about 9% in. volume, and this is exceedingly important inasmuch as the ice, as soon as it is formed, comes to the surface or remains on the surface. Take, for example, a sheet of quiet water which is cooled lower and lower by the advent of winter weather. The surface becomes cool; the cooler layers fall to the bottom until 4° is reached. Then the warmer layers stay at the bottom and the cooler layers remain on top. As soon as the surface gets to the freezing point ice forms. This ice spreads over the surface, usually from the banks towards the center, and gradually increases in thickness by conduction.

Let us consider what goes on in the case of a river which is flowing too rapidly to form a surface of ice? Naturally we will have instead of the flat surface ice, ice of finer quality formed. Each little piece of ice produced by the cooling of air on the surface is carried down by the currents and submerged, rising to the top again as the currents carry it above. Not forming the protecting layer of ice the flowing river loses a very much greater amount of heat, and the fine ice is produced by agitation in very great quantities.

These fine crystals of ice which are formed, and which are called frazil crystals, are swept down with the current, and are carried by the current for long distances from open water under the surface ice. It was one of the discoveries of the Flood Commission of Montreal that this ice was found many miles below the bordage ice at the foot of the Lachine Rapids, where the greater portion of this ice is formed. An inspection of the many diagrams of the Flood Commission for various sections of the St. Lawrence River below the city of Montreal, shows immense accumulation of frazil. It was found on examining this ice that it was very spongy. In determining the depth of the ice a leaded weight could be lowered through by slight pressure from above, and it was found that this ice accumulated under the surface ice to depths ranging from 30 to 35 ft. That it acted as a filter to the water which penetrated it was shown by the accumulation of a great deal of matter from the water, just as a sponge accumulates slime from water. The great bulk of this ice which they found was manufactured in the Lachine Rapids, and in the reaches of open water extending about six miles from the ice sheet on Lake St. Louis. They found in many places below the rapids that there was more ice than water. The percentage of this ice became less further and further below, until finally, some twelve miles below, the frazil was exceedingly scarce. In general, wherever an open river flows unprotected, quantities of this frazil ice are formed by radiation and by convection of air currents and wind agitation. These crystals of ice vary in size, depending upon the agitation of the water. The more rapid the agitation the finer they are, and the further they travel the larger they grow.

There is another form of open water ice which we must consider, and which is primarily the subject of this paper, namely, anchor ice. Anchor ice and frazil ice are often mistaken for the same thing; as a matter of fact, we must draw a line between the two. Frazil ice is ice formed in the water itself by surface agitation and other causes. Anchor ice is ice that grows on the bed of the river, on the rocks, on anything in the bed of the river to which ice may be attached.

There is still a difference of opinion as to how this anchor ice grows; how it first forms; but I think when we consider the amount of heat which is lost from the surface of a river by radiation and the fact that much of this heat can penetrate through the water, that we must admit that radiation plays an important part. When we consider further that this anchor ice is formed only at night, when the radiation from the earth is a maximum, that as a rule it never grows under a bridge or under any object which would reflect the heat rays back again into the water, and when we consider that anchor ice apparently grows more rapidly on dark rocks than on light rocks, then we must admit there is strong suspicion that radiation plays an important part in its formation. That anchor ice is built up as well by the freezing to the bottom of frazil crystals goes without saying. It could not be otherwise. These surface currents carry down the fine pieces of ice, which passing across the layer of anchor ice which may have formed there by radiation become attached, and we have then great thicknesses built up in a single night. Anchor ice is formed partly by radiation and partly by the sticking to the bottom of these frazil crystals. Anchor ice, during a severe spell of weather, when it is cloudy by day and clear by night, attains a thickness of several feet, such that a pole or a stick placed on the ice will sink into it to considerable depth. When the sun rises it has been noted for a long time that these masses rise to the surface. The boatmen are very chary about going across an open channel when the sun is bright, for these masses come up in great quantities. As soon as the sun gets at a sufficient angle so that its rays penetrates the water, they pass through the water and ice, warm the bed of the river and warm the water in contact with the ice. The ice rises with a characteristic hissing noise several feet above the water and then falls back turning white as the water drains out of it. It floats low in the water because it is saturated and waterlogged just as sawdust will float lower in the water than an equal mass of solid wood. The fact that these anchor ice masses float lower in the water than a similar weight of packed ice would, has given rise to the opinion that anchor ice was ice denser than normal and therefore held down by its own weight. There is no evidence whatever to show that ice of a greater density than normal exists and we therefore disregard that idea as being entirely untenable. Ice at one particular density is formed and only one. The reason of anchor ice being fastened to the bottom is that it is actually frozen there. As evidence of its buoyancy, large masses of rock are sometimes brought up with the anchor ice and carried down the river. Anchor ice will carry large boulders which fill up the channel of the river, and that is one thing the Montreal harbor commissioners have to contend with in the harbor there. They have annually removed a large amount of rock and boulders carried down by the anchor ice. This anchor ice when it comes up becomes disintegrated and is carried down with the currents, thus aiding the frazil in causing the daming up of the channel.

Now it was the problem set me by the Harbor Commissioners to determine if possible that where the relations between the temperature of the water, if any, and the formation of anchor ice on the bottom, and the peculiar agglomeration of frazil crystals that take place during very cold weather. It is a great difficulty that the engineer has to contend with in clear water with wind agitation that these little harmless particles grow in size very rapidly and form hard masses to which other crystals immediately adhere. Under certain atmospheric conditions ice agglomerates very rapidly and objects placed in the water become rapidly coated with ice. It is a common phenomena that if one lowers a bit of iron or mental into the water when the water is in this state that the iron will freeze at once to the bottom or to whatever ice it comes in contact with.

We designed a suitable form of resistance thermometer and undertook in the winter of 1896 to determine if possible any variation in temperature from the freezing point under the surface ice. Accordingly, a shanty was provided for the instruments in a suitable spot opposite Montreal, and in February of that year the instruments were taken out and observations commenced.

The results of these observations have been published, and it was found during the entire time, with a variation of air temperature from 28 below to 40 above zero, the river under the surface ice never varied as much as 0.01° from the freezing point. That during the entire time of the observation no deviation as much as that could be measured and as a rule the variations were within a few thousandths of a degree. A severe spell of cold weather would cause a slight drop in temperature and vice versa.

The following winter, observations were made at the Lachine Rapids because it was considered that possibly the water under the ice opposite the city came to the freezing point because it flowed so far under the surface sheet of ice. Just at this point the water was running at a very high velocity. This sheet of water is entirely open and flows rapidly from a point about five miles above the dam and sweeps around this curve with a tremendous velocity and a great deal of surface agitation.

Therefore one would expect that if water ever got cooled much below the freezing point it would have a chance in this case. The water was only a few feet deep near the dam but became rapidly deeper as we got out. The thermometer tube could be bent and placed at quite a distance under the ice edge so as to be protected from radiation. Measurements were carried out for about six weeks in this position and we got slightly greater variations than under the surface ice the winter before, but as far as the lowering of temperature was concerned it could be limited within 0.01° Cent. grade, and the greatest lowering of temperature observed during a very severe day was 0.006°.

During the two days of rain the river was fairly well cleared of floating ice; very little ice could be seen. On the twelfth, a very stormy day with a high wind, 21.1 miles an hour; no sunshine; a mean temperature of about 7°, we found a lowering of the temperature of seven thousandths of a degree and the measurements corresponded very closely for the current and quiet water. During this day the river was filled with fine particles of frazil and a great deal or ice was formed.

Table I. illustrates very clearly that the margin between the disintegration of the ice and the formation of the ice is exceedingly narrow, only a few thousandths of a degree. The high temperatures are all influenced by the sun's rays being absorbed in the water.

Table II is reproduced to show the effect of the sun's rays in the water.

On the 13th of February, 5 ft. from the surface, we got a measurement 0.0186° Cent., the air temperature being 16° F., at 2 ft. it was 0.0474° Cent. Although the air just above it was at 16° F., on the fifteenth similar measurements were made. During the time that measurement, which is the same locality as before, the deep current and quiet water, 3 feet from the surface, were both 0.0423°. The sun clouded over and the effect was at once seen in that the temperature had dropped from 0.0423° C. to 0.0112° C. Now if the sun had remained cloudy and the air cool the water would have dropped to the freezing point and a little below. The great influence which the sun has in warming the water is illustrated by the fact that anchor ice never forms and river ice never has any serious effects while the sun is shining.

When the air temperature is sufficient to cause a rapid abstraction of heat the process of freezing goes on and the temperature falls slightly below the freezing point. The reason for this is probably that ice only crystallizes at a fixed rate. If we abstract heat rapidly enough and the water cannot freeze rapidly enough to keep the temperature up to the freezing point the only thing that can happen is that the temperature must drop a little below.

When the reverse process takes place and heat is applied to the mass of water, the ice will not be able to melt fast enough to keep the water cool, and the mass will in consequence be a little above the freezing point. The less the amount of ice present the more the temperature will rise or the lower the temperature will fall for any given rate of gain or abstraction of heat.

I hope I have made it clear that what we have always considered to be a fixed and definite temperature, namely, zero centigrade, or 32 degrees Fahr., is really not absolutely fixed. It varies a little one way or the other, depending upon whether the mixture is receiving heat rapidly or losing it rapidly.

Evaporation would have quite a considerable influence on the loss of heat and consequent formation of ice, but it is probable that it is small compared to the other agencies at work. At night we have a clear sky practically free from water vapor, and, therefore, the heat is almost unabsorbed. That is, it passes through the layers of air without any reflection back again. On a cloudy night the rays are reflected back into the water. General calculations can only be made under given conditions. The average heat we receive from the sun is about 0.05 calorie per square centimeter per second.

We know about what the surface of a black body will radiate or how much heat will be given off. Such surface radiation is about 0.0003 calorie per square centimeter per second per degree difference of temperature.

That seems very small, but if you consider what the radiation is from the large surface of a river it seems much greater.

Suppose we make a calculation of how much heat would be radiated at 32° F. to air of 6° F. We find by calculations that about 4½ lbs. of ice would be formed per square yard per hour. But if we consider the radiation from the water surface at night into space at absolute zero then we would get 80 lbs. per square yard per hour formed. So you see how very much greater the radiation would be on a clear night and what a large proportion of ice would be formed. That is merely by radiation. Of course these calculations are based on assumptions which very seldom hold rigidly in actual con-

TABLE I.

Date.	Air Temperature Fahrenheit —Degrees.— Max.	Min.	Sunshine in Per Cent. if Possible.	Sky.	Wind in Miles per Hour.	Difference from Freezing Point in —Degree Centigrade.— Current.	Quiet Water.
Feb. 3d	+ 20	+ 10	89	Clear	28.6	0	.....
" 5th	+ 32	— 3	88	"	9.7	.....	+ 0.0215
" 7th	+ 38	+ 27	00	Raining	13.1	+ 0.0197	+ 0.0182
" 8th	+ 34	+ 28	00	"	16.3	+ 0.0547	+ 0.0415
" 11th	+ 18	— 3	94	Clear	6.5	+ 0.0137	+ 0.0151
" 12th	+ 11	— 2	00	Stormy	21.1	— 0.0065	— 0.0068
" 13th	+ 17	0	100	Clear	15.1	.....	+ 0.0186
" 15th	+ 33	+ 24	67	Clear to cloudy	17.6	+ 0.0280	+ 0.0423
March 1st	+ 22	— 10	25	" " "	16.8	.....	0

TABLE II.

Date.	Sunshine in %.	Locality.	Diff. from 0° C.	Air Temp.
Feb. 14th	100	5 ft. from surface (bottom)	+ .0186	+ 16° Fahr.
"	"	1 " " "	+ .0474	"
"	"	8 in. " " "	+ .0741	"
"	"	Shallow current	+ .0461	"
"	67	3 ft. from surface	+ .0423	30° sky clear.
Feb. 15th	"	8 in. " "	+ .0819	"
"	"	Just under edge ice	+ .0292	"
"	"	Deep current	+ .0280	"
"	"	Bottom of back water, sun clouded	+ .0112	30° cloudy.

dition. From the river bottom there would be a smaller proportion of ice formed. We would get an inch of solid ice formed in about 6 to 6½ hours.

A FRENCH LOCOMOTIVE WITH WATER-TUBE BOILER.

The excessive and increasing troubles with locomotive boilers on the Algerian lines of the Paris, Lyons & Mediterranean Ry. have led to the construction of a locomotive with a water-tube boiler designed by Mr. Jacques Robert, Engineer of Rolling Stock and Traction of the Algerian system. The exterior appearance of the engine is that of a locomotive with boiler of very great diameter. The design is shown in the accompanying cut. There are two horizontal drums, the upper one being the larger and carrying the dome; these are connected by three water legs. The rear of the smaller drum is connected by return tubes to a hollow frame forming the base of the side of the firebox. The sides and rear of the firebox are formed by vaporizing tubes placed close together and expanded into the hollow frame and the upper drum; the main system of tubes consists of tubes expanded into the lower drum and opening into the upper drum. Plates covering the firebox and boiler tubes prevent the entrance of air, and form the supports for the boiler. This boiler was built at the shops at Algiers, and was applied to a consolidation freight engine (2-8-0), identical with other engines of the 0-8-0 class. The comparison of the boilers is as follows:

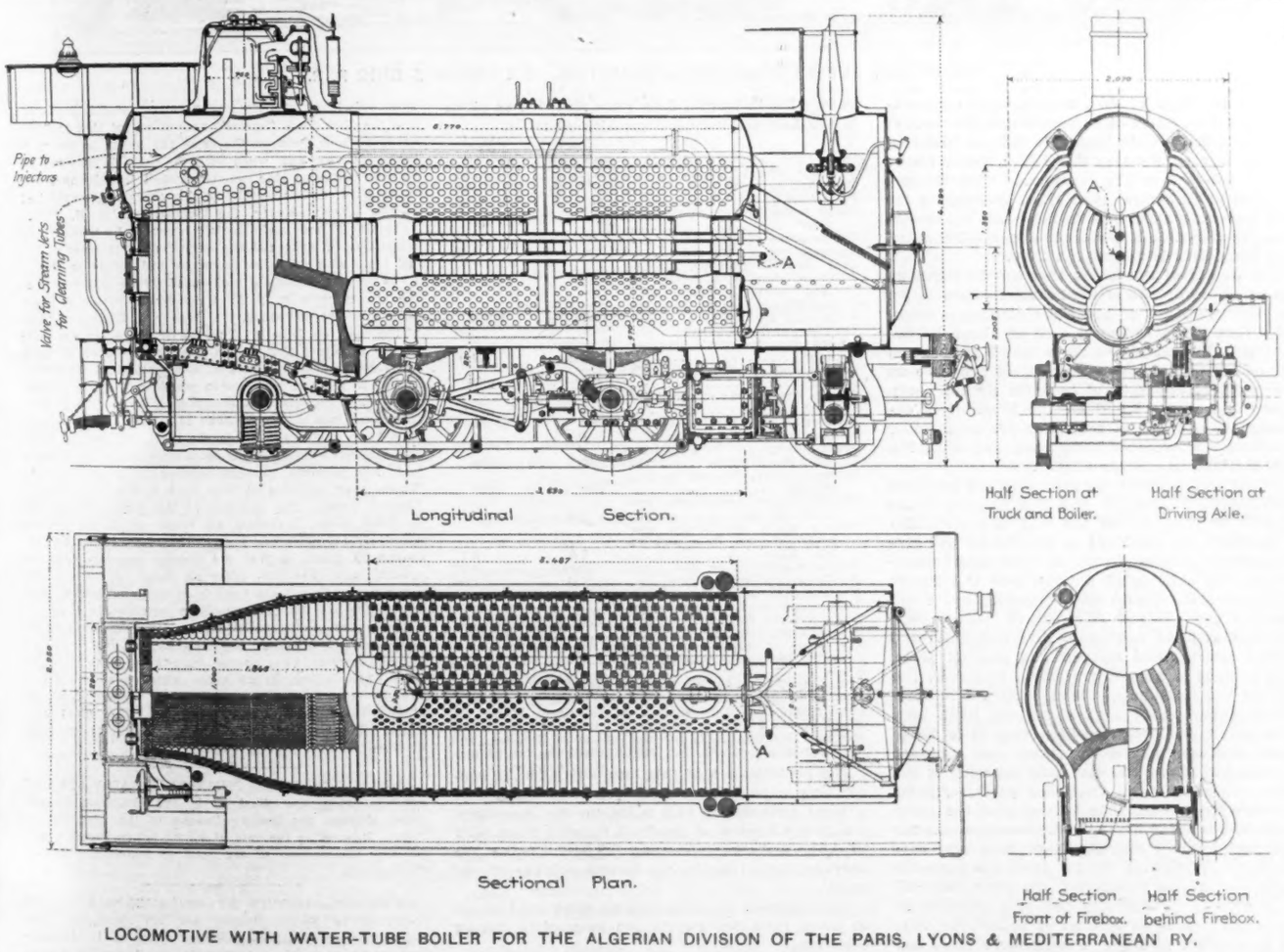
	Ordinary.	Water-tube.
Grate, length	6.00 ft.	6.00 ft.
" width	3.28 "	3.44 "
Grate area	19.8 sq. ft.	20.8 sq. ft.
Tubes, No.	208	616
" " back and sides of firebox	....	68
" " tubular system	....	428
" " partitions	....	120
" diameter, exterior	2 ins.	2.6 ins.
" length, horizontal	12 ft.	....
" " firebox (vertical)	....	5.60 ft.
" " tubular system (vertical)	....	3.98 "
" " partitions (vertical)	....	7.97 "
Heating surface, firebox	105.40 sq. ft.	165.70 sq. ft.
" " tubes	1,146.00 " "	1,043.72 "
" " drums and water legs	....	74.24 cu. ft.
" " total	1,251.40	1,283.66
Length of row of tubes	....	12 ft.
Capacity of boiler	211 cu. ft.	300.0 cu. ft.
Volume of water at high level	166.0 cu. ft.	248.9 "
Volume of water at low level	130.6 " "	204.8 "
Volume of steam at low level	88.2 " "	93.6 "
Weight of boiler empty	15.0 tons	13.5 tons
" " " full	18.5 "	19.3 "
Height of c. of gravity above rail	7.52 ft.	7.47 ft.
Cost of boiler, without accessories	$5,100	$4,300

2%. At first trouble was caused by the formation of a non-conducting coat of soot and ashes on the tubes, which necessitated thorough cleaning when in the roundhouse. To prevent this, a steam jet apparatus was installed. Two heavy pipes, A, A, were placed between the rows of tubes and pierced with oblique holes 0.12-in. diameter. The blower is turned on and steam admitted to the pipes, the soot and ashes being cleaned from the surfaces of the tubes by the steam jets and discharged from the smokestack. This enables the engine to be kept in good steaming condition, and the engine hauls trains 25% heavier than the similar engines with ordinary tubular boilers having the same heating surface and grate area.

The tubes were originally of copper, but these developed minute cracks after runs of 18,600 to 24,800 miles. Steel tubes were then used, and up to the end of January, 1905, had been in service for runs aggregating 37,300 miles, and were in good condition. Deposits of mud in the drums are very small, but deposits gradually form in the tubes, being very hard in the tubes which are in direct contact with the flame. Brushes, hammering the tubes, and tube cleaners on flexible shafts have been used.

The life of the firebox and the tube section adjacent to it cannot be foretold, but it is certain that the repairs will be less frequent and the cost of maintenance less than in the ordinary boilers. The engines fitted with water-tube boilers will have a greater capacity, especially in mounting heavy grades, owing to the facility for pushing the fire and raising steam rapidly while ascending grades, and then lowering the pressure quickly when descending. The cleaning of the tubes will also be less troublesome and will take less time than in the ordinary boilers under the conditions experienced on this road. The above information is taken from an article by Mr. Saussol in the "Revue Generale des Chemins de Fer."

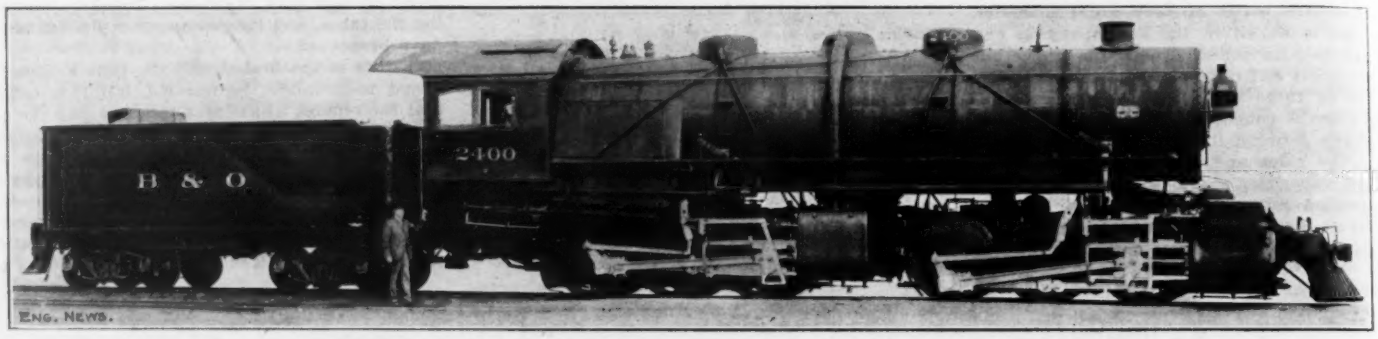
The engine with water-tube boiler was put in service in February, 1904, between Algiers and Affieville, and was worked part of the time with two crews in order to increase its service. The distance is 74 miles, and there are grades of 1 to



LOCOMOTIVE WITH WATER-TUBE BOILER FOR THE ALGERIAN DIVISION OF THE PARIS, LYONS & MEDITERRANEAN RY.

PERFORMANCE OF THE BALTIMORE & OHIO RY.'S MALLET COMPOUND LOCOMOTIVE IN SERVICE.

The huge Mallet articulated locomotive, which attracted so much attention in the railway exhibit at the St. Louis fair, has been in actual service on the Baltimore & Ohio Ry. during more than five months past, and the first records of its performance have just become available. Through the courtesy of the railway company we are enabled to give in the following a summary of the experience and observations gathered in its use. The locomotive was quite fully described in our issue of June 30, 1904, pp. 605-606, where a view of the complete engine and drawings of various parts were also given. We reproduce herewith a view of the complete locomotive. The engine weighs 334,500 lbs., all of which is on drivers. Including the tender (in working order) its weight is 479,500 lbs. The drawbar pull is about 70,000 to 74,000 lbs. compound, and about 84,000 lbs. simple. For further particulars we refer to the article already mentioned.



THE MALLET DUPLEX COMPOUND LOCOMOTIVE. BALTIMORE & OHIO R. R.

After the close of that exhibition, the locomotive was brought to the Connellsville Division of the Baltimore & Ohio Railroad, and put into regular service on January 6, 1905, to assist heavy freight trains over the mountain. This locomotive has made several road trips, and during the past five months has been in mountain helper service. In this time it has made about 13,500 miles. The locomotive is named No. 2400.

The weight of the trains that can be taken up the mountain by two of the heaviest consolidation locomotives in use on the same division is about 2,025 tons (in loaded steel cars of about 100,000 capacity). The weight of train that No. 2400 and one of the consolidation locomotives can take up the grade is about 3,210 tons (in similar cars). These figures are based on the locomotives operating at a speed of ten miles per hour under fair coal and weather conditions, and with No. 2400 working in compound gear.

WORKING.—From the results of the practical performance during the past five months, it has been demonstrated that the various special features which are combined in this design will give satisfactory results from an operating standpoint. The articulated feature, and the duplex compound system, with its intercepting valve and simpling gear device, Walschaert valve gear, combination hand and power reversing gear, and flexible intermediate receiver and exhaust pipes, have resulted in no embarrassment whatever. The curving and tracking qualities, when the locomotive is going ahead or backing up, have been satisfactory, and there has been very little flange wear, although all driver wheels are equipped with flanged tire. The steaming capacity of the boiler, working of all frictional parts, cylinder packing, piston and slide valves, and the other features that go to make up the requirements for maximum hauling capacity, have been very satisfactory. While the 2¼-in. diameter tubes in the boiler of this locomotive are very long, 21 ft., practically no difficulty has been experienced due to choking, or on account of boiler-tube, firebox or staybolt leakage. Furthermore there has been no trouble on account of priming or lubrication. While it has been noted that quite a number of changes in the minor details would be desirable, should other locomotives of this type be constructed, still when taken as a whole the design, construction and operation can be considered as satisfactory.

MAINTENANCE.—With respect to maintenance, future performance must determine, but from present indications the cost per ton-mile will be no greater than that for ordinary consolidation types of helper locomotives.

COAL CONSUMPTION.—When operating over combination level and mountain divisions, No. 2400 will consume less coal per ton-mile than the various types of simple consolidation locomotive now in the service, and when operated on comparatively level lines, it consumes materially less coal per ton-mile. On the mountainous part of the division, the fuel consumption per ton-mile is lower than for simple consolidation locomotives, but not to such a great extent as when working on the more level portions of the division.

ROAD RECORDS.—In averaging up the performance of several through freight trips made during the month of January, 1905, over the runs Connellsville-Rockwood and Connellsville-Sand Patch, these through freight runs being from 44 to 60 miles in length, data were recorded as given in the first column of the subjoined table:

	Road Service.*	Helper Service.
Running time	5 h. 29 m.	1 h. 45 m.
Time lost by stops	3 h. 38 m.	2 h. 16 m.
Total time of trip	9 h. 7 m.	4 h. 1 m.
Speed while running, miles per hour	9.7	9.1
Temperature of atmosphere	33° F.	17° F.
Temperature of feed water	33° F.	33° F.
Coal used (Bituminous, run-of-mine, about 40% volatile in road service, about 20% volatile in helper service), pounds per trip	24,900 lbs.	8,225
Pounds coal consumed per square foot of grate area per hour	61.8	66.0
Pounds coal consumed per mile run	472	584
Pounds coal consumed per thousand ton-miles	215	308.5
Number of loaded cars hauled	34	39
Number of empty cars hauled	0	0
Gross tonnage per train (in tons of 2,000 pounds)	2,193	2,049
Boiler pressure, lbs. per sq. in.; average	220	218
Pounds water evaporated per pound of coal	6.4	5.4
Pounds water evaporated per pound of coal from and at 212° F.	7.9	6.7
Minimum gradient on line	level	0.2%
Maximum gradient on line	1.0	1.0%
Average gradient on line	0.5%	
Total water used while running, lbs.		39,142
During stops, lbs.		6,652
Total, during trip, lbs.		45,794
Proportion of total water during trip used while locomotive was standing		14.5%

*On the 1% grade, 6½ miles in length, No. 2400 was assisted by one of the regular consolidation type locomotives. On all other portions of the line, where the gradients are 1% for a distance of 1 mile, .75% for a distance of 5 miles, .68% for a distance of 2 miles, and others from .3% to .5%, No. 2400 handled the train alone.

The performance of this locomotive for 24 consecutive trips helping trains and operating over a total distance of 14.8 miles up the mountain, the first 8.3 miles of gradient ranging from 0.2% to 0.5%, and the remaining 6.5 miles being 1%, averaged as given in the second column of the table.

One engineer and one fireman were used on all of these tests to operate the locomotive during each trip.

In mountain-helper service, locomotives are frequently required to remain at work for extraordinary periods between fire cleanings, and during such intervals with the forcing of fires to the maximum, doing short service and pushing trains up the grade, together with drifting down grade, and long time between trips, there is considerable opportunity for variation in the temperature in the fire-box and flues, which would tend to cause leakage and failure. Under such conditions, however, No. 2400 has been able to meet the requirements, and at the same time, make use of an ordinary grade of run-of-mine bituminous coal, and maintain ample boiler pressure at all times to handle the work.

It may be added that the greatest curvature on the line over which No. 2400 operates is about 9°, while on the heaviest grade, there is a reverse curve of about 7°.

PHENOMENALLY HIGH TRAIN SPEEDS were recorded on two railway lines in this country during the past week, in connection with the rivalry between the Pennsylvania R. R. and the New York Central & Hudson River R. R. for fast passenger service between New York and Chicago. The matter was initiated by the resolution of the Pennsylvania to run an 18-hour train between New York and Chicago, a distance of close to 1,000 miles. Almost coincident with the announcement of this resolution was the New York Central's announcement that the time of its 20-hour train on the same run would be cut to 19 hours. A year ago, when both the roads in question put 20-hour trains on this run, the fastest long-distance railroading (in regular service) in this country was exhibited. Shortly after, however, the Pennsylvania R. R. discontinued its 20-hour train, mainly because of a great freight congestion in sight and the excessive interference of this fast train with the other passenger and freight service.

The present seasons of high-speed rivalry was opened on the Pennsylvania R. R. by a run from Chicago to Pittsburg over the Pittsburg, Ft. Wayne & Chicago division of the road, on June 8. The run of 468 miles was made in 440 minutes; that is, an average speed of 64 miles per hour, including all stops, was maintained for over 7 hours; 28 minutes was lost in stops, so that the average speed while running was 68 miles per hour. The 18-hour train went into service on June 11. The westbound train, New York to Chicago, made the trip in 17 hrs. 38 mins. The eastbound train, at the same time, made the distance in 17 hrs. 37 mins. (leaving Chicago 2.45 p. m., June 11, central time, arriving at New York 9.22 a. m., June 12, Eastern time). The distance of 905 miles was covered in 1,057 mins., including all stops, or at an average speed of 51½ miles per hour. The stops during the run totaled 39 mins., so that the average running speed excluding stops was 53½ miles per hour. It is said that much better time could have been made on several parts of the line had the engineers been permitted to do so.

On the same day a record-breaking run was made on the Lake Shore & Michigan Southern Ry. (of the New York Central system), by a special train from Buffalo to Chicago. The distance is 526 miles, which was covered in 7 hrs. 50 mins., including stops. The average speed, including stops, was 68 miles per hour. This speed, continued for nearly 8 hours, makes the run the fastest long-distance railway run on record.

BIDS FOR BUILDING PHILIPPINE RAILWAYS 1,100 miles in extent are called for by the Philippine Government, through the Insular Bureau of the War Department. Interest at the rate of 4% on bonds issued to pay for the construction of the road is guaranteed by the Government.

MUNICIPAL REFORM AT PHILADELPHIA is being continued by Mayor Weaver and his associates. The Mayor has appointed an advisory board of 14 members with whom he proposes to consult on all municipal business during the remainder of his term. The membership includes Messrs. John H. Converse, of the Baldwin Locomotive Works, Hugh McCaffrey, President McCaffrey File Co., Charles Emory Smith, Editor of the Philadelphia "Press" and Ex-Postmaster-General, and a num-

...bankers, merchants and other prominent citizens. ... resignations of city officials in the interest of re... have been received during the past two weeks, and ... superfluous employees have been and are to be ... from the city pay roll. Suspiciously numerous ...rations of voters from the residences of policemen ... other employees are being investigated and city em... have been notified that membership in and pay... of assessments to political clubs are not essentials ... holding office. This week interest centers in the pro... repeal of a group of street railway ordinances, ...tually turning over 110 miles of streets, some not ...graded, for 50 years to the local street railway com...ny. Franchises for these streets were rushed through ...few years ago but will soon expire from non-use. The ...ordinances which it is proposed to repeal authorize con...tracts under which the city would agree not to give ...franchises on these streets to any competing company ...for 50 years. The iniquitous character of the ordinances ...is second only to that of the gas lease extension ordinance ...which precipitated the present reform movement. The ...organization" is said to be sparing no effort to prevent ...the passage of these repealers, hoping thereby to make a ...show of strength, rally its forces and prepare for re...gaining the control it has been losing so rapidly of late. ...Moreover, it is said that the 5,000 employees of the trac...tion interests would be a valuable aid in restoring the ...prestige lost through the diversion of the support of many ...city employees.

TESTS OF STRUCTURAL MATERIALS on an extensive scale are to be undertaken by the government in cooperation with private individuals, according to a recent report from Washington. On invitation of the Secretary of the Interior, a meeting of officials of the Geological Survey and the Bureau of Forestry and interested private persons took place. A program was outlined for testing structural materials as wood, stone, cement, etc., and coal. An advisory board of engineers and chemists to work with the Geological Survey and the Bureau of Forestry will probably be formed.

A SERIOUS INTERRUPTION OF SUBWAY TRAFFIC occurred in the Rapid Transit Subway of New York City on June 11. A large water main in Fourth Ave., near 42d St., burst on the evening of June 11, and so much water entered the subway through the sewer drains that traffic was stopped at that point. The flow in the broken main was not stopped until some four hours after the break, a fact due in part to the accident occurring on Sunday. Pumping out the water accumulated in the Subway continued most of the following day, and traffic past the point of accident was not resumed until early Tuesday morning, June 13. The structure of the Subway was not injured but much minor damage was done. The Mayor of the city has recommended to the Commissioner of Water Supply, Gas and Electricity, and to the Fire Commissioner, that an arrangement be made, if possible, to enable the firemen in case of necessity to find the gate-valves in water mains so as to shut off the water.

THE WALSCHAERT VALVE GEAR for locomotives, which is beginning to be introduced in this country has the important advantage of a material saving in weight as compared with the Stephenson gear, and this advantage is especially important on the large engines now so generally used. One of the new 113-ton consolidation (2-8-0) freight engines of the Lake Shore & Michigan Southern Ry. is fitted with the Walschaert valve gear, which weighs 2,382 lbs., as compared with 3,665 lbs. for the Stephenson valve gear on the other similar engines, a saving of 1,283 lbs. For two classes of passenger engines of the 2-6-2 type, the Stephenson gear weighs 3,940 and 4,685 lbs, while it is estimated that the Walschaert gear would weigh 2,725 and 2,940 lbs., representing a saving in weight of 1,215 and 1,745 lbs. respectively.

WOMEN TRACERS are to be employed in the drafting offices of the British Naval Dockyards and the decision has started public discussion in England regarding the employment of women in engineering offices. In a letter published in the London "Times" Engineering Supplement a Member of the Institute of Naval Architects, Mr. Jas. A. Smith, states that women are largely employed in the drawing rooms of private shipbuilding firms in England. We print the substance of his letter, as follows:

> In some of the large Clyde shipbuilding yards women are employed not only to do the whole of the tracing of proposals, contract, and working plans, but also to work out many of the intricate calculations of displacements, positions of metacenters, etc. Long experience has shown that the tracing can be neatly and reliably done, and the mechanical working out of calculation—sheets satisfactorily performed, the latter having, of course, all the multipliers, etc., printed in, and the ordinates, intervals, etc., filled in beforehand by the draftsman in charge of the work.
>
> The immediate result of this is to free the draftsman, and particularly the apprentice, from a vast amount of mechanical and uninteresting work. There are few young draftsmen who do not deplore the time wasted during their term of training on tracing and week-long multiplying and dividing. Usually the chief draftsman is too busy a man to adequately oversee the distribution of the more mechanical work of the office, and this applies equally to his immediate assistants, or "leading hands." Consequently, an apprentice or junior draftsman may be kept for years doing little else but tracing, and this is almost inevitably the case if he happen to appear a trifle less bright and pushing than his fellows. If the young man has spent some years in the yard or shops, or at a technical college, before entering the drawing-office, such an experience is an absolute waste of the most valuable part of his life. Again few fully-trained draftsmen care to be employed on tracing work, and from the point of view of both the technical "heads" and the firm there is a palpable waste in having high-class men employed at any time on low-class work. Therefore, the exact reproduction of plans by tracing, which has to be done for practically every plan drawn, is a serious hindrance to the learner's advancement, a nuisance to the busy "chief," and a matter of consideration in the standing charges of the firm.
>
> Where women have been specially trained to do this work, and a proper system of checking and supervision is in force, the result is good. There is always some difficulty in getting the more important notes, words, and lines on a plan sufficiently emphasized in the tracing, which in female hands tends to run to a dead level of uniformity, and the "dotted line" trouble can never be entirely eliminated. With these exceptions, I have often been surprised at the small amount of touching-up afterwards required, and also at the able manner in which a tracer of some years' experience will handle the tricky and elusive "ship curves." Generally speaking, the work so produced is infinitely preferable to the indifferent scratching of a young apprentice or the hasty work of older draftsmen, each of whom has, besides, his own style of drawing and lettering.
>
> In a large Clyde ship drawing-office where part of my training was acquired, about 25 women tracers were constantly employed. They commenced their four years' apprenticeship at the age of about 15, and during this period received a salary commencing at 5s. per week, rising to 12s. Afterwards their salary was 20s., rising to about 23s. within a few years, and in some cases higher. The hours of work were the same as those of the draftsmen. Each plan was drawn with a view to its being traced by a non-technical person, the small amount of extra work involved being fully compensated for by the additional clearness of the details to the other draftsmen having occasion to refer to it. The kind of lettering and the general style of the tracings were fixed by rule, and as soon as a tracing was finished it was carefully compared with the original and touched up here and there. It was usually sent back to the tracing office for the rectification of any large errors, and this was generally preferred by the draftsmen, the ladies seeming to have a better knack of making erasures, etc., neatly. The time required for tracing even the most intricate drawings compared very favorably with that taken by a good draftsman.
>
> In the course of several years spent with this firm I heard no complaints about the women ousting men. My own experience is that a draftsman who has taken the trouble to master his work need never fear female competition.

It is an illustration of some of the conditions that enable British shipbuilders to underbid the rest of the world in marine construction that they can employ women tracers at wages of $5 to $5.75 per week in their drawing offices.

SOME TESTS OF THE ELASTICITY AND THERMAL EXPANSION OF STONE.

In "Stone Industry in 1903," just published by the U. S. Geological Survey, there is a mass of valuable information on the properties of stone, much of which is new. Tables of compression tests occupy many pages; but perhaps the most interesting, because they are so scarce, are the tests showing coefficients of heat expansion and moduli of elasticity.

With one exception, all the tests on the coefficient of expansion were made on granite columns about 20 ins. long, between 32° and 212° F.

The following are all the tests given.

	Coef. of expansion per 1° F.
Arkansas granite (Little Rock)	.00000341
Arkansas granite (Little Rock)	.00000324
California granite (Exeter)	.00000461
Massachusetts granite (Cape Ann)	.00000311
Maine granite (Monson)	.00000311
Main slate	.00000500

A few tests on the modulus of elasticity of granite pieces 20 ins. long, 4 × 6 ins. cross-section, tested under compression, are as follows:

	Modulus of elasticity.
Maine granite (Mill bridge)	9,800,000
Arkansas granite	6,950,000
Arkansas granite	8,100,000
Arkansas granite (156.2 lbs. per cu. ft.)	6,090,000

Beside the above, eight tests on granites from the State of Washington are given, showing an average modulus of elasticity of 3,220,000; but, as the range is from 1,532,000 to 5,070,000, and as the tests appear to have been made on 2-in. cubes, there is doubt as to the reliability of these Washington granite tests. Incidentally it may be added that the eight Washington granite specimens showed an ultimate compressive strength of 14,600 lbs. per sq. in. Seven specimens of Washington sandstone, tested in 2-in. cubes, showed an average compressive strength of 6,700 lbs. per sq. in., and an average modulus of elasticity of 1,140,000 lbs. per sq. in.

PERSONALS.

Mr. Irving H. Reynolds has been elected Vice-President and General Manager of The William Tod Co., of Youngstown, O.

Mr. Geo. H. Thomson, M. Am. Soc. C. E., has opened a consulting engineering office in the Park Row Building, New York City.

Mr. A. Bement, M. Am. Soc. M. E., mining and mechanical engineer, Chicago, has moved his offices from 218 La Salle St., to 215 Dearborn St., Chicago.

Mr. Clarence Morgan, of Burlington, Vt., has been appointed Professor of the new Railway Engineering Department of McGill University, Montreal, Que.

Mr. Charles Hansel, M. Am. Soc. C. E., has been appointed Consulting Engineer of the Indiana Harper Ry., with offices in the La Salle Station, Chicago.

Mr. J. W. Vogleson, of 1810 Chestnut St., Philadelphia, Pa., has been appointed Assistant to the City Engineer of Manila, P. I., and will sail June 23, from Seattle, Wash.

Mr. F. G. Jonah, M. Am. Soc. C. E., formerly Chief Engineer of the St. Louis, Brownsville & Mexico R. R., has been appointed Terminal Engineer of the New Orleans Terminal Co., with office in New Orleans, La.

Mr. J. J. Harris, formerly connected with the engineering department of the Denver & Rio Grande R. R., has been appointed Chief Engineer of the Pacific & Idaho Northern R. R., with headquarters at Weiser, Idaho.

Mr. J. A. Herrick, M. Am. Soc. C. E., has become associated with the Whiting Foundry Equipment Co., of Harvey, Ill., as Consulting Engineer, and will be located for the present, as formerly, at Philadelphia, Pa.

Mr. Frank P. Foster, Secretary of the International Association of Municipal Electricians, has resigned his position as Superintendent of Fire Alarms in Corning, N. Y., to become electrician at the Corning Glass Works.

Mr. Robert C. Adams has been appointed Hydrographic Aid and has been assigned to work at Boston, Mass. He is a student in the Massachusetts Institute of Technology and has been engaged as assistant by the Massachusetts Harbor and Land Commission.

Mr. George Y. Wisner, M. Am. Soc. C. E., of Detroit, Mich., has been appointed a member of the International Waterways Commission to succeed Prof. Gardner S. Williams, M. Am. Soc. C. E., resigned. Mr. Wisner is now serving as Consulting Engineer of the U. S. Reclamation Service.

Mr. Verney W. Russell, of New Hampshire, has received an appointment as Engineering Aid in the U. S. Reclamation Service and has been directed to report for duty at Cody, Wyo. Mr. Russell is a graduate of Dartmouth College and had considerable experience in connection with his college work.

Mr. Frederick L. Humphrey, of New York City, has been appointed Engineering Aid in the U. S. Reclamation Service, and will be engaged for some time in the Washington office. Mr. Humphrey has had extensive experience in civil engineering in connection with his college course in the Columbia University.

Mr. Adolph H. Rossing, of Madison, Wis., has been appointed Engineering Aid in the U. S. Reclamation Service, and has been ordered to report for duty to Mr. J. B. Field, at Ft. Laramie, Wyo. Mr. Rossing took a general scientific course in the University of Wisconsin and was graduated from the College of Mechanics and Engineering with the degree of C. E.

Mr. George Gibbs, M. Am. Soc. C. E., formerly Vice-President of Westinghouse, Church, Kerr & Co., and Consulting Engineer of the Interborough Rapid Transit Co., of New York, is now Chief Engineer of Electric Traction of the terminal operations of the Pennsylvania R. R., in New York, and Chief Engineer of Electric Traction of the Long Island R. R.

Mr. K. G. Sing, M. Can. Soc. C. E., Engineer in Charge of the Public Works of Canada, in Western Ontario, has been appointed Acting Engineer in charge of the District of Eastern Ontario, which was up to the time of his death in charge of the late Major Henry A. Gray. Mr. H. J. Lamb has been appointed as Acting Engineer in charge, at London, Ont.

Mr. Lathrop Crosby, of Tacoma, Wash., has been appointed Engineering Aid in the U. S. Reclamation Service, and has been assigned to work under Mr. John E. Field, Ft. Laramie, Wyo. Mr. Crosby attended the Sheffield Scientific School of Yale University and has had experience with railroad and mining companies and with the Reclamation Service.

Mr. Edward L. Edes, of Reading, Mass., has received an appointment as Engineering Aid in the U. S. Reclamation Service, and has been requested to report to Mr. G. L. Swendsen, Salt Lake City, Utah. Mr. Edes who is taking a course in the Massachusetts Institute of Technology has had practical experience in connection with his college course in civil engineering.

Mr. Henry A. Young has been transferred from the office of the U. S. Engineer, Ft. Washington, Md., to the Reclamation Service and will report to Mr. H. N. Savage, Billings, Mont., for duty. Mr. Young is a graduate of the College of Civil Engineering of Cornell University, and has served with different railroad companies and in various engineering capacities during the war with Spain.

Mr. A. W. Walker has received an appointment as Engineering Aid in the U. S. Reclamation Service, and has been assigned to duty at Belle Fourche, S. Dak., under the supervision of Mr. Raymond F. Walter. Mr. Walker had a course in civil engineering in the Massachusetts Institute of Technology and has had practical experience with the Metropolitan Water and Sewerage Board of Boston.

Prof. George W. Plympton, M. Am. Soc. C. E., head of the Department of Civil Engineering in the Polytechnic College of Arts and Engineering of Brooklyn, N. Y., will, it is announced, retire from that position at the close of the present academic year. Prof. Plympton began his service with the Polytechnic Institute in 1863, as Professor of Physical Science, and since 1890 he has been connected with the Civil Engineering Department.

Mr. George R. Kempton has been appointed Electrical Engineer in the U. S. Reclamation Service, by transfer from the U. S. Treasury Department. He will report for duty to Mr. H. A. Storrs, Denver, Colo. Mr. Kempton was graduated from the Tufts College, receiving the degree of B. S. in electrical engineering. He has had considerable experience in his line in New York and the New England States and in the Treasury Department.

Mr. Leroy F. Harza, of Madison, Wis., Engineering Aid in the U. S. Reclamation Service, has been assigned to duty under Mr. C. S. Slichter, Madison, Wis. Mr. Harza attended the South Dakota Agricultural College and is now taking a scientific course in the University of Wisconsin. He was County Surveyor of Moody Country, S. Dak., for two years and has been engaged in surveying for sewer location.

Mr. Walter S. Harrington, of Wadsworth, Nev., has been appointed Engineering Aid in the U. S. Reclamation Service and will be engaged under Supervising Engineer L. H. Taylor, with whom he is now associated as "field assistant." Mr. Harrington was graduated from the University of Nevada as a mining engineer and has been employed on the Truckee High Line canal under the direction of Prof. Chandler.

Dr. Samuel G. Dixon, of Philadelphia, Pa., President of the Academy of Natural Science, has been appointed Commissioner of the Department of Health of the State of Pennsylvania. This commission, which was created at the last session of the legislature to take the place of the State Board of Health, is to consist of an advisory board of six members. The salary attached to the position is $10,000 per year. Doctor Dixon is 54 years old; a graduate of the Medical Department of the University of Pennsylvania, and afterwards Professor of Hygiene in the Medical and Scientific departments of that University. He became connected with the Academy of Natural Sciences as Curator in 1891, became Executive Curator in 1892, and President in 1896.

Mr. J. Edward Simmons, President of the Fourth National Bank of New York City, Mr. Charles N. Chadwick, President of the Charles N. Chadwick Co., of Brooklyn, N. Y., and Mr. Charles A. Shaw, President of the Hanover Fire Insurance Co., of New York City, have been appointed by Mayor McClellan, members of the commission which is to lay out and supervise the construction of a new system of water supply for New York City. Mr. Simmons, who has been elected President of the Commission, was appointed as the representative of the Chamber of Commerce, Mr. Chadwick was appointed as the representative of Merchants' and Manufacturers' Association of Brooklyn, and Mr. Shaw was appointed a representative of New York Board of Fire Underwriters. Each of the above mentioned associations submitted a list from which the selections were made. Mr. Chadwick has been elected Acting Secretary of the Commission, each member of which is to receive a salary of $12,000 per year.

Obituary.

Julius P. Marsh, Superintendent of the Standard Underground Cable Co., of New York, while installing an underground cable system for the Brooklyn Rapid Transit Co., was struck by a motor train June 10, and died shortly after his removal to the Coney Island Hospital.

John Bennett, prominently connected with the Mechanical Department of the Central Railroad of New Jersey at Junction and Elizabeth, N. J., died June 9, at the home of his daughter in Verona, N. J. Death followed an operation for cancer of the lower jaw. He was born in Brownsburg, Pa., in 1839, and was a veteran of the Civil War.

George Henry Clark, at one time Resident Engineer for the Erie Canal, died June 3, at his home in Brooklyn, N. Y., aged 87. As a civil engineer Mr. Clark made surveys for the Genesee Valley Canal, and aided in laying out the New York Central R. R. He was Superintendent of the Albany & Northwestern R. R., until 1858, giving up that position to become Resident Engineer for the Erie Canal. He was also engaged in the construction of the Welland Canal. He retired from active engineering work about 35 years ago.

William Black, M. W. Soc. E., Chief Engineer for T. E. Hill & Co., contractors, Chicago, was killed in a railway accident May 18. He was for some years Chief Engineer of the South Park Commission, Chicago, and was a joint inventor of a system of concrete block construction which was used with success for some of the park buildings and was described in our issue of May 21, 1903. Mr. Black was born in Scotland in 1866, and came to this country in 1888. He leaves a widow and family.

Robert Cartwright, M. Am. Soc. C. E., died June 4, of acute pneumonia at his home in Rochester, N. Y. Robert Cartwright was born in Philadelphia, Pa., in 1830, and was educated in the public schools of that city. After leaving high school he became an apprentice in the Port Richmond Iron Works, of Philadelphia, soon becoming a first-class draftsman and designer, and later foreman and superintendent. During the Civil War he was engaged on the construction of monitors and other small vessels for the Navy. During this time he was given the title of Chief Engineer in U. S. Navy. After the war, in partnership with his brother, he built numerous gas works and water-works in various cities. He was also engaged for some time in the construction of bridges for railroads on the Pacific Coast. For a time he was located in Ithaca, N. Y., where he engaged in a general engineering business. In 1872 he settled in Rochester, N. Y., where he took up the manufacture of carriage and bus axles. In 1890 he retired from this business to engage in practice as a consulting engineer. While in Philadelphia Mr. Cartwright was an active member of the Franklin Institute, and later when in Rochester he was prominent in the building up of the Rochester Engineering Society. He was Director of the American Society of Civil Engineers in 1895-96 and 97, and Vice-President in 1899-00. He was a man of upright character and integrity and was ever ready to assist young engineers.

Captain James W. King, Chief Engineer, U. S. Navy, retired, died June 6, at his home in Philadelphia. Mr. King was born in 1820 in Maryland, and was appointed from that State in 1844, as third Assistant Engineer of the United States Navy. He served on all the original small steamers owned by the Government, and was attached to the Mississippi during the war with Mexico. In 1852 he was promoted to be Chief Engineer, and soon thereafter appointed, under act of Congress, Inspector of ocean steamers at the port of New York. In 1855 Mr. King was transferred to Philadelphia, to superintend the construction of the machinery for the Wabash, one of the largest ships then in the navy, and served during her first cruise. In 1861 and 1862 he was Chief Engineer of the Atlantic fleet and participated in the capture of the forts at Hatteras, under Admiral Stringham, and Port Royal, under Admiral Du Pont. On March 15, 1869, President Grant appointed him Chief of the Bureau of Steam Engineering, and in 1873 he was appointed General Inspector of engineering works and sent to Europe to collect information of useful appliances for the navy. In 1875-76 he again visited Europe under orders to examine and report on ships of war and the mercantile marine. The result of this tour was published, by order of the United States Senate, in a report called "European Ships of War." This was reprinted in England. In 1880 Mr. King published an illustrated volume entitled "The War Ships and Navies of the World," He was one, if not the first, officer of the navy to advocate and take a decided stand in favor of iron and steel for the hulls of war vessels.

ENGINEERING SOCIETIES.

COMING MEETINGS.

MASTER CAR BUILDERS' ASSOCIATION.
AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION.
June 14-21, 1905. Annual meeting at Manhattan Beach, N. Y. Secy., J. W. Taylor, The Rookery, Chicago, Ill.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.
June 19 to 23, 1905. Annual convention at Asheville, N. C. Secy., R. W. Pope, 95 Liberty St., New York, N. Y.

AMERICAN SOCIETY OF CIVIL ENGINEERS.
June 20 to 23. Annual convention at Cleveland, Ohio. Secy., Charles Warren Hunt, 220 West 57th St., New York, N. Y.

ASSOCIATION OF TRANSPORTATION AND CAR ACCOUNTING OFFICERS.
June 20, 21, 1905. Annual meeting at Toronto, Ont. Secy., G. P. Conard, New York, N. Y.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION.
June 28, 29, 1905. Annual meting at Atlantic City, N. J. Secy., Prof. M. S. Ketchum, Boulder, Colo.

AMERICAN SOCIETY FOR TESTING MATERIALS.
June 29-July 1. Annual meeting at Atlantic City, N. J. Secy., Prof. Edgar Marburg, Philadelphia, Pa.

PACIFIC COAST ENGINEERING CONGRESS.
June 29 to July 1. At Portland, Oregon. Otto von Geldern, San Francisco, Cal., or Milnor Roberts, Seattle, Wash.

PACIFIC NORTHWEST SOCIETY OF ENGINEERS.
June 29 to July 1. Annual convention at Portland, Oregon. Secy., Milnor Roberts, Seattle, Wash.

LEAGUE OF AMERICAN MUNICIPALITIES.
August 23 to 25. Annual meeting at Toledo, O. Secy. J. McVicar, Des Moines, Ia.

INTERNATIONAL ASSOCIATION OF MUNICIPAL ELECTRICIANS.
August 23 to 25, 1905. Annual convention at Erie, Pa. Secy., F. P. Foster, Corning, N. Y.

AMERICAN PUBLIC WORKS ASSOCIATION.
August 30, 31, 1905. Annual meeting at Chattanooga, Tenn. Secy., W. H. Flint, Chattanooga, Tenn.

AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS.
Sept. 5 to 7. Annual meeting at Montreal, Canada. Secy., Geo. W. Tillson, Brooklyn, N. Y.

ROADMASTERS & MAINTENANCE OF WAY ASSOCIATION.
Sept. 12, 14. Annual meeting, at Niagara Falls, N. Y. Secy., C. E. Jones, C., B. & Q. Ry., Beardstown, Ill.

INTERNATIONAL ASSOCIATION OF MUNICIPAL ELECTRICIANS.—Owing to conflict of dates with other conventions, the annual convention of this association has been shifted to August 23, 24 and 25, a week earlier than had been planned. Many efforts are being made to have a successful and largely-attended convention. Mr. Wm. Crane, Erie, Pa., is in charge of the local arrangements.

AMERICAN SOCIETY OF CIVIL ENGINEERS.—The last meeting of the season 1904-05 was held at the society's house, 220 W. 57th St., New York, on the evening of June 7. Two papers were presented: "A Few Points in the Design of Reinforced Concrete Arches," by Mr. B. R. Leffler, and "Theory of the Spherical Dome of Reinforced Concrete or Metal," by Prof. Wm. Cain. There was no discussion of moment.

AMERICAN CHEMICAL SOCIETY.—The annual business meeting of the New York Section, held at the Chemists' Club, 108 W. 55th St., New York, on the evening of June 9, had an interesting and varied program of papers. Three of the papers dealt with subjects of organic chemistry, as follows: "Some Condensation Products of 1 Phenylnaphthalene, 2-3 Dicarboxylic Anhydride," by N. A. DuBois; "Isomeric Ethers in the Quinazoline Group," by H. A. Sell and M. T. Bogert; and "Acyl Derivatives of 4-Amino-methyl-phthalate," by R. R. Renshaw and M. T. Bogert. Both organic and inorganic chemistry was involved in a paper by Prof. L. H. Friedburg on "The Preparation of Hydrobromic and Hydriodic Acids." The author prepared these acids by dropping bromine and iodine, respectively, into melted paraffine or vaseline, whereby, under the action of heat, the acids were obtained directly, in satisfactory purity or easily purifiable. In conjunction herewith the author showed several new pieces of laboratory apparatus which proved valuable in the work. Most interesting of these was a distilling flask for the recovery of ether, petroleum spirit or the like, wherein an electric incandescent lamp is the source of heat. Most conveniently a straight-bulb (cylindrical) lamp is used, set in vertical position in a porcelain socket. The flask has its bottom formed into a return tube of such diameter and length that the flask may be slipped over the lamp, being thus held in place and heated at the same time. No attention need be given to the apparatus while the distillation proceeds, and there is absolutely no risk of fire. Two papers on the element praseodidymium, one of the two elements into which Welsbach split didymium, were presented by Prof. C. Baskerville, J. B. Thorp and G. B. MacNider. The first described the formation of a true tetroxide, PrO_4, with the incidental formation of a colored soluble salt first suspected to be a salt of eka-manganese but later shown to be a salt mainly of iron. A special feature of the work was the use of a crucible of sodium carbonate, to avoid all contamination by metals forming colored soluble salts. The second paper described various experiments adapted to reveal any tendency of the praseodidymium to separate into the components which are suspected to be contained in it; all results, tested by the spectroscope, were negative, so that as yet there is no further ground to support the suspicion of the complex character of the element. A paper by A. Bourgougnon and C. Baskerville, "Artificial Willemite," dealt with a phase of the modern physical study of fluorescense, phosphorescence and radiations. The mineral willemite, a zinc silicate, when subjected to ultraviolet light rays exhibits both fluorescence and phosphorescence; that is, it displays color or luminosity both during and after exposure to the rays. The authors prepared the mineral artificially, using pure materials, and found it to be unresponsive to the rays. Addition of various metals was tried, some of which gave either fluorescence or phosphorescence; only manganese, however, gave both effects. The final paper of the evening was "The Production of Boron Carbide from Boric Oxide in the Electric Furnace," by H. V. Bliss and S. A. Tucker. Boron carbide was extensively studied by Moissan and exhibits very interesting properties, for example, it will scratch carborundum and may be used for diamond-cutting. The authors studied the procedure for its production more fully, having best success with an arc furnace. They conclude that the manufacture of boron carbide on commercial sale is possible.

The election of officers of the section for the coming year resulted as follows: Chairman, F. D. Dodge; Secretary, F. H. Pough.

ENGINEERING LITERATURE

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The Modern Asphalt Pavement.

Reviewed by S. Whinery,* M. Am. Soc. C. E.

THE MODERN ASPHALT PAVEMENT.—By Clifford Richardson, Director, New York Testing Laboratory, Long Island City, N. Y. New York: John Wiley & Sons. London: Chapman & Hall, Ltd. Cloth; 6 × 9 ins.; pp. 580; tables, and 32 figures in the text. $3.

Mr. Richardson's book occupies a field in which there has heretofore been a great dirth of adequate literature. To it the trite expression may be truthfully applied that it fills a long-felt want.

The asphalt paving industry has, in this country, occupied a somewhat anomalous position. The pavement was patented, and, later, the only source of supply of asphalt then available in this country came under the control of those engaged in promoting and constructing the pavement, so that for a long time the business was practically a monopoly. The proper compounding of the materials used and the laying of the mixture on the street required a very considerable degree of knowledge and skill which was acquired only by study and experience, and the possessors of this special information not unnaturally regarded it as private property, and rather sedulously guarded it from the public and from competitors when they appeared. The disposition to do this has practically continued until the publication of Mr. Richardson's book. The earlier pavement was not without defects and its promoters set about remedying these as far as possible. At first the efforts in this direction were confined to the practical side of the work and to empirical methods. But it was soon appreciated that exact and scientific investigation and treatment was necessary to the attainment of success. Mr. De Schmet, who may be said to be the father of this kind of street paving, himself a chemist, gave some attention to this side of the industry.

The City of Washington, where the pavement was first used to any considerable extent, in order to properly supervise the work, created the position of "Inspector of Asphalts and Cements." Mr. Richardson was called to this position, and he established there the first municipal laboratory devoted to the study of asphalts and asphalt pavements, and the work has been ably continued by his successor, Mr. Dow. Before 1890 the two leading companies engaged in constructing the pavement, appreciating the necessity for greater scientific knowledge on the subject, had established private laboratories, well equipped for chemical and physical investigation, and Mr. Richardson became director of one of these. They took up the study of the whole subject more exhaustively and upon a larger scale than had been before attempted.

In the changes which took place in the business about 1899 these two laboratories were merged under the direction of Mr. Richardson, and he has continued the work ever since. Working independently as had been the two laboratories, upon the same problems, and, as it appeared, along substantially parallel lines, Mr. Richardson's own investigations were thus supplemented by whatever was of value in the work of the other laboratory. He has continued to be the chemist and expert of the combination known as the "Asphalt Trust," and as such has practically dictated the composition and technic of all the pavements constructed by the various constituent companies of that organization.

These introductory remarks seem appropriate, not only to give an idea of the situation of the industry previous to the publication of Mr. Richardson's book, but to show his peculiar qualifications for writing a book on the subject of asphalt pavements. It is quite safe to say that no man living is so competent as he for the task.

The book is the only treatise on the subject which merits the name. Previous publications have consisted of a few detached professional papers before the engineering and scientific societies, articles and discussions in the technical periodicals, and various municipal reports, first among which, in importance, have been those of the Commissioners of the District of Columbia, including the reports of the Inspector of Asphalts and Cements, which have contained a great deal of value. The book is also notable as being the first authoritative presentation of the subject by a representative of the asphalt paving companies, thus making public the results of long and patient investigation by them, not heretofore accessible to the municipal engineer. It is rather unusual for contractors in any special field of municipal work to establish laboratories and conduct scientific investigations at great expense for the sole purpose of improving the quality of the work done by them, and, while they were actuated chiefly by business motives, they deserve proper credit for what they have done to advance the industry.

Turning now to the book itself a quotation from the "Introduction" may best present the aim and motive of the author:

> During an extended experience in the asphalt-paving industry, which has included the inspection of the construction of asphalt pavements on behalf of a large city and the technical supervision of the work of several prominent companies which contract to lay them, it has been forced upon the attention of the writer that engineers, and others who are interested in obtaining the best results, have not been made sufficiently acquainted with the technology of the industry and with the importance of some of the engineering details involved to enable them to differentiate, at the time that the pavement is being laid, or even on its completion, between good, bad, or medium work. Cities have, consequently, been obliged to rely on the statements and good faith of contractors, with the result that many asphalt pavements have eventually proved unsatisfactory, although when completed they were, to all outward appearance, of good quality—a condition which might have been readily avoided either by an intelligent supervision of the materials in use and the manner of handling them, or by a change in the form of construction.

Structurally, Mr. Richardson divides an asphalt pavement into three parts or courses; the base, the intermediate course, and the surface course. Chapter I. treats of the base, more frequently called by engineers the "foundation." He calls attention first to the importance of a suitable subsoil or earth foundation upon which the "base" is directly placed, and to the necessity of properly compacting this, and of proper underdrainage where the soil is wet and heavy. Describing the function of the "base" and the various materials and forms of construction used for this part of the pavement, he concludes that "hydraulic concrete, if properly proportioned, made with good cement and a well-graded aggregate, well mixed and put in place satisfactorily and in good weather, is the ideal base." Nearly seven pages are devoted to the qualities of the materials used and the methods of mixing and placing concrete base, and its proper thickness. His statement that for concrete base "It is, therefore, much better to avoid using the natural cements . . ." and that, for the purpose, "Portland cement is infinitely preferable to natural cement," will not be accepted by the many engineers whose experience has demonstrated that a satisfactory concrete pavement foundation can be made with the natural cements, and that the choice between Portland and natural cements should be determined largely by their relative economy, when each is used in the proper ratio to produce the best results. Of a kind of base very largely used in New York City and to a smaller extent elsewhere he says:

> Old granite-block pavements have been very extensively used for supporting asphalt surfaces, especially in New York City, and their value for this purpose and the defects which result therefrom are well illustrated there. Granite blocks laid in sand on the soil have been found very satisfactory on cross-town residence streets, but have been most unsatisfactory on streets like First Avenue, where the subsoil is soft, fills are frequent, and partly on land below high-water mark in bringing the street originally to grade. These blocks could be seen to move under the steam-roller when the binder course was laid, and the asphalt surface is, in consequence, in constant need of repairs. The only base which would prove satisfactory under these conditions would be, considering the heavy travel on the street, the best form of Portland cement concrete to a depth of at least eight inches.
>
> Granite blocks on a concrete base make an excellent base for an asphalt surface, if not reset, but where the grade necessitates taking them up and replacing them on their broad sides the result is not so satisfactory except on residence streets. When relaid they are not rigid, but have a tendency to rock under heavy travel. Such a base supports the asphalt surface on Broadway and several avenues in New York City, and has not been entirely successful. The turned blocks were opened to travel for some time to bed them thoroughly, and any loose ones reset. The binder and surface were then laid directly on the blocks. The vibration on these blocks, especially along the rail, is nevertheless large. A better form of construction would be to grout the blocks, after turning, with Portland cement, and keep traffic off of them until the grout is set. The lesson is that turned granite blocks should not be used as a base for asphalt pavements on streets of heavy travel, even when supported by a Portland-cement base, and much less so on soil alone, as has recently been done on Fourth Avenue in New York City.
>
> Construction of this description inevitably results in deterioration of the best asphalt surfaces, with the results that the defects are attributed to the asphalt and not to the base where they really originate.

These views are eminently sound and to the point. He might have gone further and stated that to place an asphalt surface upon such a foundation of loose blocks, on streets of heavy or even moderately heavy travel, is usually a wasteful expenditure of the city's money.

Chapter II. (8 pages) is devoted to the "Intermediate course of the pavement, formerly called the 'cushion coat' and later the 'binder course.' " The so-called binder course came into great vogue about a dozen years since. If Mr. Richardson did not originate it, he has been until very recently its earnest advocate. It is gratifying to the reviewer, who, from the first, opposed the use of this binder course, to find that Mr. Richardson has come to the same conclusion, so far at least as its use on streets of heavy travel is concerned. As a substitute he now advocates a course composed of rather smaller crushed stone with the screenings left in, the voids of which, when laid, are filled with standard surface-course mixture. This is undoubtedly a move in the right direction, and, if generally adopted, will lead to a marked improvement in our asphalt pavements. The author gives the typical composition of this improved course, and engineers will do well to note and embody it in all their future specifications. The reasons given by Mr. Richardson for the abandonment of the present fashionable binder course are quite sufficient to condemn it, though he might well have added to and strengthened

*Consulting Engineer, 95 Liberty St., New York City.

them. He mentions that some of the defects of the binder course can, perhaps, be removed by abandoning it entirely and substituting a course of thick paint, composed of asphaltic cement dissolved in benzine. The only merit of this paint course is that it tends to exclude water from the surface course, which, for reasons that will be referred to later, Mr. Richardson considers *sine qua non*. The statement that this paint course was first used in 1896 is not accurate, a paint course composed of coal tar, pitch and benzine having been tried experimentally on a street in Peoria, Ill., as early as 1892, but the results did not seem to justify its general adoption.

In Chapter III. the subject of the "surface course" or wearing surface is taken up, and the consideration of the materials used and the composition of the surface mixture occupy this and the three succeeding chapters (designated together as Part II. of the book) some 275 pages being devoted to the subject. To the municipal engineer and the pavement expert the most interesting and valuable part of the book is here entered upon. This is true not only because the wearing surface of the pavement is its most important part, but also because here we have for the first time the full and frank statements and opinions of a high authority in the asphalt paving industry who is at the same time the controlling authority in the technical department of what is known as the "Asphalt Trust," and who therefore speaks, as it were, "from the inside," backed by the accumulated knowledge and experience of many years, which has not heretofore been regarded as belonging to, or accessible to the public. Mr. Richardson's position enables him to present this authoritatively, and without any implication of the ethical bad faith that might attach to a similar publication by others, who had opportunities for acquiring at least a part of the information.

Chapter III. (56 pages) is devoted to the consideration of the sand, which forms usually about 85% of the mass of the surface mixture. In the earlier history of the industry it was generally believed that the quality of the pavement depended principally on the quality, quantity and proper manipulation of the cementing element—the bitumen—and the quality of the sand was not regarded as of very great importance. Investigation and experience showed in time that the importance of the sand element had been underestimated, and as far back as ten years ago it began to dawn upon experts that the character and quality of the sand aggregate used was an element of controlling importance. The present view is well expressed by the author when he says " . . . it is now pretty well known that, even if all the other constituents of an asphalt surface mixture are of the best, the wearing surface will not prove a success unless the sand is suitable for the purpose."

A new and more complete classification of sands than has heretofore been proposed is offered, and the principal varieties are described in detail. It is shown that while the shape of the grains and the character of their surface are not to be ignored, the most important requisite in sand for asphalt pavement is that the mass shall be made up of grains of assorted sizes. A typical sand for the purpose is described as consisting of the following percentages by weight of grains passing the sieves designated.

				Per cent.
Passing	No	200	Mesh sieve	0
"	"	100	" "	17
"	"	80	" "	17
"	"	50	" "	30
"	"	40	" "	13
"	"	30	" "	10
"	"	20	" "	8
"	"	10	" "	5

Attention is called to the usual wide variation in the sizes of the meshes or openings in sieves purporting to be the same, and to the importance, and incidentally to the difficulty, of obtaining sieves that are uniform and accurate. Attention is also called to the element of percentage of voids in different sands, though it is doubtful if the author attaches as much importance as it merits to this element. It may be noted, however, that a mass of sand composed of grains of the assorted sizes recommended will always present a low percentage of voids.

Chapter IV. treats of the pulverized stone dust, which is an important element in the pavement mixture. The summary at the end of the chapter may be quoted to give an idea of its contents:

The character of the filler or finely ground inorganic matter which enters into the composition of the mineral aggregate of an asphalt surface has been shown in the preceding chapter to be a matter of very considerable importance. Impalpably fine mineral matter of various kinds can be satisfactorily used, but it should be as fine as possible, and for construction of an asphalt pavement on streets of heavy travel Portland cement should alone be used as a source of supply.

Chapter V., "The Nature of the Hydrocarbons which Constitute the Native Bitumens," will be found of more interest to the chemist than to the engineer. Chapter VI. gives the author's classification of bitumens, and while valuable to the scientific student, it will not greatly interest the engineer.

Part III. of the book, entitled "Native Bitumens in use in the Paving Industry," comprising chapters VII. to XIV., inclusive, occupying in all about 170 pages, is by far the best descriptive treatise extant upon the asphalts and bitumens that are or are supposed to be available for asphalt pavements. It is so full of matter of interest to the paving engineer and expert that any attempt to abstract or condense it is hardly practicable. The titles of the several chapters convey a good idea of the scope and value of this part of the work: Determination and Characterization of the Native Bitumens; Petroleums; The Solid Bitumens; Individual Asphalts; Solid Native Bitumens which are not asphalt; Asphaltic Sands and Limestones; Residual Pitches, or Solid Bitumens derived from Asphaltic and other Petroleums; Comparison of Various Native Asphalts and their Relative Merits for Paving Purposes.

Some matters of present special interest may be noted. The question of the suitability, for paving purposes, of bitumens resulting from the distillation of crude petroleum oils is just now attracting a good deal of attention and the author's views upon the subject are of special interest, because he has studied these products closely both in the laboratory and at the plants where they are produced; and as the corporation with which he is associated has been, and presumably is still engaged, in their manufacture, his opinion should be, and doubtless is, free from prejudice.

The residues from California petroleum have been used to a very considerable extent in the paving industry and are generally known as "D" grade asphalt or under some trade designation or brand, such as Diamond, Obispo, or Hercules.

They are all more or less carelessly manufactured without laboratory control and consequently vary in character and consistency. As a rule they are by-products resulting from the recovery of distillates of different gravities from crude petroleum and are not prepared especially for paving purposes. That they are badly cracked in the process of manufacture, the oil often being heated as high as 900° F., appears from the fact that if the petroleum from which they are obtained is distilled or evaporated under such conditions that cracking will not occur, as much as 60 per cent. of a hard residue will remain, as shown by the following figures obtained in the author's laboratory, as compared with 30 per cent. by industrial methods.

After showing that these products differ quite widely from each other, and reviewing the causes that lead to these differences, he says:

These differences characterize the California pitches as being, to a certain extent, products of decomposition and on this account undesirable material.

Considered as a class they are also undesirable because they are not uniform in character, as shown by the different degree of solubility of the bitumen in cold carbon tetrachloride, and by the very considerable variation in the amount of fixed carbon which they yield.

Mr. Richardson calls these products "Residual Pitches" and the name is so convenient and appropriate that it should be generally adopted. It should be said, and it is to be at least inferred from the author's statements, that many of these residual pitches, if properly manufactured at temperatures which will not injure them, should, and do, make excellent pavements. The objection to them as they appear on the market is that being a residual or by-product they are not manufactured with the necessary care, that they are often injured by overheating, and lack the degree of uniformity in quality which is right enough; essential in an asphaltic cement for paving purposes.

The qualities that are considered essential or desirable in an asphalt for paving purposes are considered in Chapter XIV., and the conclusion arrived at is that upon the whole the product from the Island of Trinidad is superior to all others. This conclusion will not be universally accepted. It is possible that the reader will not be favorably impressed by the effort apparent throughout the book to exploit the superiority of this variety of asphalt, and he may surmise that this effort is not entirely disinterested. That the views expressed represent the sincere convictions of the author, none, and particularly no one who knows him, will question. The matter is one in which there is room for honest difference of opinion, and it is therefore the more to be regretted that the author should allow himself to charge that those who do not agree with his conclusion are generally actuated by sordid and unworthy motives, as he does near the end of the chapter on page 440.

It seems convenient to consider, in this immediate connection, Chapter XXIII., the title of which is "Action of Water on Asphalt Pavements," since conclusions as to the relative value of Trinidad asphalt hinge largely on the question whether the admitted deterioration of that material in the presence of water is or is not a defect of sufficient importance to condemn its use in pavements. This question is just now attracting much attention and is being vigorously debated. It is not appropriate in a book-review to discuss the question at length, but at the same time the reviewer can hardly pass unchallenged statements of the author which are not accepted as conclusive by others whose opinions are entitled to weight. Mr. Richardson's argument may be briefly outlined as follows: While it is admitted that Trinidad asphalt, whether in the laboratory sample or in improperly compound pavements, is disintegrated by exposure to water or excessive moisture, it is claimed that when the paving mixture is properly made and placed on the street the sample or in improperly compounded pavements, or that, at least, it is not more injuriously affected by water than other varieties of asphalt; and that this fact coupled with the superior qualities of Trinidad asphalt in other particulars makes it, upon the whole, the best material yet found for the cementing element in an asphalt pavement.

Those who do not concur in this argument and conclusion say: That Trinidad asphalt, whether in the crude or the refined state, or in combination with the other materials of an asphalt pavement, is attacked and sooner or later destroyed by water; that this defect is inherent in the bitumen itself, and no remedy for it has been found; that in pavement mixtures of such close texture as to retard the absorption of water the process of disintegration is delayed but not arrested, and that it is therefore only a question of time and degree of exposure to water when the pavement will be destroyed, regardless of other conditions. It is freely admitted that in other respects Trinidad asphalt possesses excellent qualities, though some of these may be apparent rather than real, but it is claimed that even if these be conceded they are not sufficient to compensate for an inherent defect which it is believed has in many cases done more to shorten the life and usefulness of the pavement than all other causes combined. In so far as the penetration of the pavement by water can be controlled or prevented, deterioration from this cause will be lessened, and partly, at least, for this reason the author places great emphasis upon efficient drainage, impervious concrete foundation, and surface mixtures of great density. It is further to be remembered that only about two-thirds of the mass of refined Trinidad asphalt is bitumen, while in a number of others, at least nine-tenths is pure bitumen, and, other things being equal, there should be a marked advantage, commercially, to both municipality and contractor in using the purer material.

Those who care to pursue this matter further

will find it discussed (by the reviewer.—Ed.) in Engineering News for May 12, 1904, and for June 2, 1904.

Part IV. (Chapters XV. to XVIII., inclusive, 105 pages), under the general title of "Technology of the Paving Industry," treats of the refining of asphalts, the composition and character of asphaltic cements, the proportions of the surface mixture, asphaltic concretes, and the preparation of the surface mixture, including a description of the plant used. This part of the book is of the highest practical value. The reader will doubtless be surprised at the care and attention to details which these chapters clearly show has been devoted to the theory and practice of constructing asphalt pavements by the better class of contractors. The meagerness and inadequateness of the ordinary city specification stands out in strong contrast with the definite and detailed practice here disclosed. It will be seen, in fact, that not only does the average specification fail to describe and require the best modern practice in the industry, but that in some respects it seems to prohibit the doing of the work in the best manner. It is at least quite safe to say that the work is often done with more care and at greater expense to the contractor than the specifications call for. One effect of the publication of this book will be, or should be, the revision of the specifications in common use by our cities, but this is a work that calls for the assistance of the expert. Chapter XIX. deals with the practical work of placing the pavement mixture on the street, and Chapter XX. with "The Physical Properties of Asphalt Surfaces."

Part VII., entitled "Specifications for and Merits of Asphalt Pavements," contains three chapters. The set of specifications submitted as a model (Chapter XXI.) would hardly be accepted by the municipal engineer fully conversant with the subject. They lack explicitness and necessary detail and allow the contractor more latitude than is considered wise in other departments of municipal work.

Part VIII., treating of "Causes of the Defects in, and Deterioration of Asphalt Surfaces," will be found of great interest and value to the paving engineer, whether all the views held by the author are accepted or not. His reference to the destructive action of illuminating gas on asphalt pavements deserves the widest attention. Part IV., in four chapters, relates to "Control of Work," and is a very full exposition of the functions of the laboratory and the expert in directing and controlling the selection of materials and the proper execution of the work. The director of the municipal laboratory will find in this part of the book a great deal of interest and value to him.

In conclusion it is not too much to say that Mr. Richardson's book should be classed with those which appear too infrequently, but whose appearance mark epochs in the industry to which they relate. Even if the dictums of the authors are not always accepted or vindicated, they set people to thinking and mark out new paths for future progress.

Andrew Carnegie's James Watt.

JAMES WATT.—By Andrew Carnegie, Author of "The Empire of Business," Etc. New York: Doubleday, Page & Co. Cloth; 6 × 9 ins.; pp. 241. $1.40 net.

The wonderful career of James Watt is here ably retold by a most appreciative countryman with a wealth of comment bearing on or suggested by Watt's life and inventions, which is scarcely less interesting than the narrative itself. These comments relate to the literature, education, the apprentice system, specialization in industry, capital and labor, monarchical and republican forms of government, free trade, and various characteristics of the Scotch and of notable Scotchmen. Divest the book of these various reflections and the biographical portions remaining would loose a large part of their value, although still possessed of great interest.

It is unnecessary to review here the life of Watt or to add to what has been said regarding the manner in which the ever-entrancing story has been retold. The book is well worth securing, reading and re-reading, even by those who already possess and have read other lives of the father of the modern steam engine. This suggests that it would be interesting to know how many engineers of American birth have read a life of Watt, or of Stephenson or the other founders of their profession. And it also suggests or renews the thought that in the extended biographical writing of the present day the great engineers of the world are for the most part being neglected.

Business Engineering.

LECTURE NOTES ON SOME OF THE BUSINESS FEATURES OF ENGINEERING PRACTICE.—By Alex. C. Humphreys, M. E., Sc. D., LL. D., President of the Stevens Institute of Technology. Hoboken, N. J.: Stevens Institute of Technology (Department of Business Engineering). Cloth; 6 × 9 ins.; pp. 187.

This book is, we believe, the first of its kind—namely, a book of lectures on business methods for students of engineering. It marks an epoch in the teaching of mechanical engineering; for while it has long been admitted that engineering involves not only a study of ways and means of building safe structures and efficient machines, but also of using every dollar to the best advantage, it has not been the practice of many teachers of engineering to teach business methods, or the art of cost recording and cost analyzing.

It is true that in some of the colleges of civil engineering, and in most of the colleges of mining engineering, the business side of engineering receives some consideration, usually in the form of a comparatively few unpublished lectures. In certain of the mining colleges the training in economics is quite thorough, but, outside of these, we are safe in saying that such training is generally regarded as not being essential to an engineering student, and that knowledge of business methods can best be acquired after graduation.

President Humphreys, himself an engineer successful in engineering work requiring a knowledge of business methods, apparently believes that other kinds of mental training than training in theoretical and applied mechanics are essential to an engineer's success. He also believes that the engineering college is the place to begin training engineers for a life that is to be largely a life of business.

If the drafting room, or the surveyor's field, is to be the Mecca of the engineering graduate, then such lectures as these are wasted; for it requires no knowledge of business to use a T-square or shout "up a hair." But if an engineer is to go forth from his college prepared to undertake the management of engineering enterprises in a small way, with the hope of educating himself to manage other enterprises in a large way, he should have enough training, in a small way, if you please, to give him confidence in himself.

The book before us contains 13 lectures delivered to the students of Stevens Institute of Technology. One lecture by Mr. Howard E. White is entitled "Notes on Contracts." Its only defect is its brevity. So important a subject can obviously receive only superficial treatment in a single lecture, which here fills only 32 pages. The same criticism holds true of Mr. Humphrey's lecture on "Estimates and Specifications," which occupies only 10 pages. In both lectures good advice is crowded into small space, and references are given for the student to look up. Were more references given to books and articles on these subjects, the student would be greatly helped.

By far the greater part of the book is devoted to lectures on accounting, there being 120 pages on this subject. There are three lectures on "Accounting," then follow three lectures on "Accounting as Applied to Repairs and Depreciation." The three remaining lectures have the following titles: "Systems of Classification—Taxes"; "Analysis of a Balance Sheet," and "Analysis of Data."

The titles of some of these lectures may lead one to infer that the subject of book-keeping, or, more properly, accounting, occupies most of the pages. It is true that the author does go into the principles of bookkeeping, giving sample pages of cash book, journal and ledger, and describing how accounts are opened, entries made, etc.; but the author enters in detail into many matters not treated in text-books on book-keeping. For example, he takes up the subject of plant depreciation, and shows how the life of a plant should be calculated, part by part, as distinguished from "average life."

The author tells his students that he does not expect to make book-keepers of them, nor would it be desirable to do so. His aim is to give them such knowledge of the principles of double-entry book-keeping as will enable them to understand statements of results, as well as direct a book-keeper as to the proper methods to follow in laying out a system of accounts. The author says:

> A competent analysis of accounts is as the very foundation of economical management.

And then he proceeds to prove this proposition by examples and illustrations taken from his own experience. So well does he handle the subject that interest is awakened from the start, and is not allowed to lag.

We note that there is nothing on the keeping of detailed shop-costs and costs of field-work; but we infer from a sentence on page 168 that subsequent lectures are to be given on these subjects. Moreover, President Humphreys says in his Introduction that he has not yet been able to cover by written notes all the matter included in his course of instruction to the students of Stevens Institute of Technology. We refrain, therefore, from any criticism of the book for its omissions, and heartily commend it for what it contains.

CITY LIFE AND PROGRESS.—The Annals of the American Academy of Political and Social Science. Issued bi-monthly. Vol. XXV., No. 2, March, 1905. Emory R Johnson, Editor. Philadelphia: The Academy. Paper; 7 × 10 ins.; pp. 211. $1.

The papers and notes on municipal topics, which practically fill this number of "The Annals," are significant as indicating the intelligence with which city problems are now being studied by people in various walks of life. One of the most suggestive papers in the collection outlines the development of comprehensive park systems in the United States and Canada. In another paper Mr. Lawrence Veiller, who was Secretary of the New York Tenement House Department under Mayor Low, ably discusses "The Housing Problem in American Cities." He makes a good case for municipal or other public inspection and control of tenement house construction and conditions of occupancy, rather than the municipal housing so common in Great Britain or the semi-philanthropic model tenements constructed by associations and individuals both here and abroad. The housing problem is also considered at some length in a paper on "The Progress of Sanitation in Great Britain," the author of which, A. K. Chalmers, appears to have doubts as to the wisdom of housing at municipal expense. General sanitation is not discussed in the last-named article, which is concerned with those factors which cause excessive death rates in some sections of a city, such as poor housing, malnutrition and personal imprudence and shiftlessness. Other articles deal with nomination reform, general reform in Chicago, medical school inspection, city government in Japan, and quasi public works in London. Prof. John A. Fairlie reviews "Recent Extensions of Municipal Functions in the United States," and Prof. L. S. Rowe outlines and criticizes "The Reorganization of Local Government in Cuba." A symposium on "The Activities of Civic Organizations for Municipal Improvements in the United States" has been reprinted from this volume and was noticed in this Supplement for May 18, 1905.

STATE BOARD OF HEALTH OF THE STATE OF OHIO.—Eighteenth Annual Report, for the Year Ending December 31, 1903. Springfield, O.: Pub. Doc. Cloth; 6¼ × 9¾ ins.; pp. 563; folding and other plates, and text figures.

Action on plans for water supply and sewerage, in some cases including purification, an account of a typhoid fever epidemic at Cleveland, O., numerous water analyses, brief reports from local boards of health and vital statistics for 1903, constitute the bulk of this volume. An appendix is used to present descriptions of the sewage purification works in the State, already published separately.

Marine Engines and Boilers.

Reviewed by W. F. Durand,* M. Am. Soc. M. E.

MARINE ENGINES AND BOILERS.—Their Design and Construction. A Handbook for the Use of Students, Engineers, and Naval Constructors. Based on the Work, "Berechnung und Konstruktion der Schiffsmaschinen und Kessel," by Dr. G. Bauer, Engineer-in-Chief of the Vulcan Works, Stettin. Translated from the Second German Edition by E. M. Donkin and S. Bryan Donkin, Assoc. M. Inst. C. E. Edited by Leslie S. Robertson, M. Inst. C. E., M. Inst. M. E., Secretary to the Engineering Standards Committee, Author of "Water Tube Boilers," and Editor of M. Bertin's 'Marine Boilers." New York: The Norman W. Henley Publishing Co. London: Crosby, Lockwood & Son. Cloth; 6 × 9¼ ins.; pp. 744; many tables, and 535 figures, mostly in the text. $9 net.

This work constitutes a noteworthy addition to the relatively meager literature in English relating to the broad field of marine construction. The primary purpose of the author, as stated in the preface to the first edition, was the production of a condensed treatise embodying the theoretical and practical rules used in designing marine machinery. While the work was thus primarily intended for the use of those concerned with the design of marine machinery, it was believed that certain parts, and in particular those relating to the computation of cylinder diameters, turning moment, balance of moving parts, piping and pumps, would prove of use to those concerned with the design or construction of stationary engines as well.

The work, as a whole, is divided into eight parts, each of which is variously subdivided into sections and paragraphs. Part I. deals with the main engine, and comprises a discussion of the utilization of steam in the engine, the determination of cylinder dimensions, the investigation of turning moment, balance of moving parts, arrangements of cylinders and cranks, details of engine construction, auxiliaries and attachments. Part II. deals with pumps, and includes a discussion of the various forms of pump, independent and attached, and for the various purposes required in marine service. Part III. takes up shafting, resistance of ships and propulsion, and comprises a discussion of the main shaft, line, thrust and outboard bearings, the resistance of ships as related to the problem of powering, and the design of the screw propeller to meet the varying demands of different sets of conditions. Part IV. treats of piping and connections, and includes a discussion of the various main and auxiliary systems of piping for steam and water, with the various forms of flanges, unions and connections, cocks, valves and miscellaneous fittings which the needs of marine service are found to require. Part V. deals with steam boilers, and covers the general field of draft, combustion and steam generation in modern steam boilers of both fire and water tube types, with the various mountings and attachments met with in the best practice of the day. Part VI. is occupied with measuring instruments, and comprises descriptions and discussions of the use of apparatus for measurements, such as temperature, steam pressure, flue gas analysis, draft pressure, heating value of fuels, revolutions, power, etc. Part VII. deals with various details, such as bolts, nuts and fastenings, ladders, gratings, foundations, lubrication and ventilation. Part VIII. comprises a large collection of tables and tabular matter, such as powers and roots, logarithms, trigonometric functions, conversion tables for English and metric measures, weights, strength and elasticity of various materials, Lloyd's rules for boilers and engines, weights of machinery.

Of these various parts the first is the largest, covering some 280 pages of the text, and giving an excellent treatment of its subject matter. Under the general head of design various empirical rules are given, and illustrative data drawn largely from German and Continental practice. In some cases, also, rational formulæ are developed, though of necessity the design of details must be based largely on empirical procedure. In the discussion of the problem of balancing, the main discussion is based on the assumption of an infinite connecting rod. This is equivalent to a consideration of first period forces only. The modifications arising from including second period forces are then briefly referred to as a matter of secondary consideration. This mode of treatment seems unfortunate, as implying a lack of importance for the second period forces which is scarcely in accord with the general body of observation bearing on this subject. Debate has waxed warm in recent years regarding the importance of forces of still higher period, but few have been disposed to question the really serious importance of those of the second period. The practical rules and examples of balancing which are given are excellent, in so far as they produce a balance of first period forces; but this will hardly satisfy modern requirements, and it is well known that by taking the second period forces into account a combination result may be reached which is considered much preferable to any which can be reached by a consideration of first period forces only.

The section on pumps covers some forty pages, and includes a discussion of pump design in general, illustrated by a number of actual cases drawn from practice in the German mercantile and naval marines.

In the section on shafting there is some ambiguity in the use of the term "propeller efficiency," as a result of which it is made to appear that the ratio between the actual thrust on the thrust block and the indicated thrust is the product of the mechanical efficiency of the engine and the true efficiency of the propeller. This omits the influence due to the wake. The apparent efficiency of the propeller should be used rather than the true, thus raising the value of the ratio from some 55% on the average, as stated, to perhaps 66%. The general treatment of the subjects of resistance and propulsion is excellent, and certain methods of propeller design are presented in considerable detail.

The section on boilers is the second largest of the book. It covers some 130 pages, and gives an excellent general discussion of combustion and mechanical draft, with a large amount of descriptive matter relating to the various approved types of modern marine boilers. The section includes also a transcript of the German Lloyd's rules for boilers, in which, however, the formulæ are retained in their metric form in order to avoid undue complication.

Throughout the work in general metric dimensions and formulæ have been transformed into English measure, thus entailing a very large amount of additional labor on the part of the translators, but vastly enhancing the working value of the book.

In the appendix the final report of the British Committee on Naval Boilers is given, and the work closes with a full and carefully prepared index.

The omission of all discussion of the steam turbine is justified by the author on the ground of its untried character and uncertain future as a factor in marine propulsion. The actual number of ships fitted with turbine propulsion, either afloat or building, seems hardly in accord with the view which this omission implies. Whatever may be the future of the turbine, it is beyond contest a factor of some present weight in marine propulsion, and in the opinion of most engineers, its probable role is likely to be one of increasing importance, even if it does not realize the wider expectations which some have ventured to predict.

As a whole, this work constitutes an addition of the highest value to the available literature on the subject, and the high standing of the author and unusual opportunities for the accumulation of valuable information which he has enjoyed as Engineer-in-Chief of the Vulcan Works in Stettin give additional value to the practical information which is so freely distributed through the book. Illustrative material has also been most generously furnished, both in the form of diagrams and reproductions of working drawings. The mechanical make up of the book is in the best style of the technical book maker's art, and its high professional value justifies the warmest commendation to all those who are concerned with this field of engineering work.

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A Pocket Companion for Automobilists.

THE AUTOMOBILE POCKETBOOK.—A Companion of the Gasoline Automobile. By E. W. Roberts, Assoc. M. E., Author "The Gas-Engine Handbook," "Marine Motors and Motor Launches," "Gas Engines and Their Troubles," etc. Cincinnati: The Gas Engine Publishing Co. Leather; 3½ × 5¼ ins.; pp. 125, 51 figures in the text. $1.50.

This pocketbook fills a place in automobile literature occupied by no other book. It is practically a digest of information on the most approved design and construction of automobiles published up to the present time by automobile journals. The author shows himself to be as thoroughly familiar with all branches of his subject as with the engine itself on which his "Handbook" is a standard.

The book is of undoubted value to manufacturers, but its largest field of usefulness will embrace such owners, chauffeurs and repairmen as wish to know something more than how to start, steer and stop a machine or how to replace a broken bolt.

The author's well-known partiality to the two-cycle type of engine is brought out in the first chapter. He believes that this type will, to a large extent, supplant the four-cycle motor, but probably not 2% of the machines being built this year are of the two-cycle type, nor is there much indication of many manufacturers changing to this design.

Somewhat more than one-half the book is devoted to the design of various parts, such as valve mechanisms, mufflers and axles; and detailed descriptions of the best forms now in use are given, accompanied by lettered drawings, which enable the average reader to grasp the idea at a glance. If these drawings were referred to by page instead of by figure numbers they could be found much more quickly.

Several chapters are devoted to the care of various parts of the automobile, how to locate troubles and how to make repairs. In the last chapter the author gives some practical ssuggestions for choosing an automobile.

THE CEMENT-WORKER'S HAND-BOOK.—Covering More than Fifty Most Important Subjects on Cement and Its Uses in Construction. Compiled to Meet the Requirements of the Common Workman. By W. H. Baker. (Wadsworth, O.: The Author). Cloth; 4¼ × 6½ ins.; pp. 86. 50 cts.

The author of this little book states that he has had 20 years' practice as a mason, during which time he has had a varied experience in the uses of cement. The book is itself sufficient evidence of the fact that the author has a first-hand knowledge of his subject. For example, the description of the proper way to make cement walks is the best that we have seen in print.

The book deals successively with Cements, Mortars, Concretes, and Cast Masonry, and then concludes with Practical Notes on Cement Work. Under cast masonry the author briefly describes the methods to be used in making walls, floors, ceilings, walks, curbs, posts, cisterns, grave vaults, culverts, building blocks, troughs, chimney tops, sewers, statuary and ornaments.

The book is written in language that any mason can understand, but is not filled with the colloquialisms and digressions which so often mar works of this kind.

There are no illustrations. A few line drawings to illustrate the construction of forms would have added very little to the cost of the book, but would have greatly increased its value, even to workmen who are not skilled in the interpretation of drawings.

ON TYBEE KNOLL.—A Story of the Georgia Coast. By James B. Connolly. New York: A. S. Barnes & Co. Cloth; 5 × 7¾ ins.; pp. 285; illustrated. $1.25.

This is a short, simple but interesting story of rivalry between some contractors on river and harbor work at Savannah, Ga. The young hero and his older partner have various exciting experiences in executing a contract that involved cutting and rafting some poles for dipper dredges. The rafts were stolen, rescued, cut adrift and finally rescued again. Incidentally there are races, fights and rescues on the water. The youth has an ambition to get an engineering education and to build an "electric saw mill," but the author unkindly leaves his readers in doubt as to the attainment of these objects.

The Elements of Alternating Current Machinery.

Reviewed by David B. Rushmore.*

ALTERNATING CURRENT MACHINERY.—By William Esty, S. B., M. A., Head of Department of Electrical Engineering, Lehigh University. Chicago, Ill.: American School of Correspondence. Cloth; 6½ × 9¼ ins.; pp. 412; plates, and 380 figures in the text. $3.75.

An author should either have new matter to present, a new method of presentation of old material, or a collection of existing matter, with the object of bringing together in one place what can otherwise be found only in many different sources. The author of the present volume declares that it has been prepared with the special object of giving the beginner, and the so-called practical electrician, a working knowledge of alternating current apparatus, so that he may know how to install and operate it intelligently. In doing this Professor Esty has fulfilled not alone one, but two, and those the last two, of the conditions of authorship laid down in the foregoing opening sentence, and he has done so in a manner worthy of commendation. That the mathematical formula still has the power of producing a sensation of fear is shown by his strict avoidance of mathematics wherever possible. This necessitates very clear and accurate descriptions, and a critical reviewer might find opportunity for noting a lack of precision in some definitions and statements, but for the general reader this will not be particularly misleading. The book is divided into nine different headings, and treats of the Alternator, Commercial Types of Alternators, Synchronous Motor, The Transformer, The Rotary Converter, The Induction Motor, Switchboard and Station Appliances, Special Switchboard Apparatus, and Lightning Arresters. The division of the book is, however, somewhat arbitrary, as the subject matter does not follow the same mechanical divisions.

Chapter I. treats of the principles of alternating currents, and this would be a better title for it than the "Alternator." The conceptions of electromotive force, magnets, armatures, frequencies, the advantages of alternating currents are considered, as well as the laws of power impedence, inductance, capacity, etc. A discussion follows of the various factors of the electromotive force waves and a quite complete elaboration of vector diagrams and their applications to different kinds of electric circuits. Included in this chapter, for a reason which is not quite obvious, is also a short treatment on hot wire and static instruments.

Chapter II., which is supposed to deal with commercial types of alternators, completes the treatment of static instruments, and takes up the question of measurement of power, including a dissertation on the subject of wattmeters and a description of those in general use. The equations for the generation of electromotive force are then developed, and then a treatment is given of armature reaction of regulation, and of methods of excitation and compounding. After a discussion of the theory of polyphase alternators and of armature windings, a description follows of various types of alternators, which is quite representative, and then various methods of testing these machines, together with some illustrations, showing the mechanical construction, and included is also a treatment of synchronous motors and transformers.

The transformer is quite thoroughly treated, and many good illustrations are given of diagrams and connections. The rotary converter is then taken up, and the essential facts regarding its theory and the different connections in common use are given. The various kinds of induction motors are described, including the structural details, and a more or less complete description of various machines and methods for testing the same.

The subject of switchboards is such a large one that its treatment is necessarily somewhat condensed, but the diagrams and illustrations shown are quite representative as far as they go. The book concludes with a description of special switchboard apparatus, such as fuses, induction regulators and lightning arresters.

The field covered by Professor Esty's book is so large that nearly everyone engaged in electrical work will find something of interest in it. For the technical electrical engineer there will not be much that is new, but for the class for which this book is written, as stated in the preface, there is offered an excellent compilation of up-to-date practice with regard to alternating current machinery.

*With General Electric Co., Schenectady, N. Y.

Mechanical Handling of Materials.

THE MECHANICAL HANDLING OF MATERIAL.—Being a Treatise on the Handling of Material such as Coal, Ore, Timber, etc., by Automatic or Semi-Automatic Machinery. Together with the Various Accessories Used in the Manipulation of Such Plant; also Dealing Fully with the Handling, Storing and Warehousing of Grain. By George Frederick Zimmer, Assoc. M. Inst. C. E. New York: D. Van Nostrand Co. London: Crosby Lockwood & Son. Cloth; 7½ × 10½ ins.; pp. 521; 542 figures, mostly in the text. $10, net.

This is the first book in English on the general subject of the mechanical loading and transportation of materials. It is entitled, therefore, to a more lenient criticism than would otherwise be the case. A pioneer in any line of scientific writing has many difficulties to contend with, and in this particular instance the field is so broad that the difficulties are greatly multiplied.

There are three questions that the engineer first asks about any device intended to handle materials: (1) What is the first cost of the device; (2) what is the cost of operation, including maintenance; (3) what is the maximum and what the average output. As a rule, this book answers none of these questions, except the last, and it does not always answer that. The author states in his preface, however, that he has inspected every kind of installation described in the book; but there are internal evidences that in many cases the inspection has been very superficial.

Another subject upon which the author gives next to nothing is the mechanical efficiency of each of the devices described. What, for example, is the mechanical efficiency of a belt conveyor, under given conditions? We turn to the index, and find under "Band Conveyors" such information as this: A band conveyor 12 ins. wide, running at 150 to 350 ft. per min., has a capacity of 10 to 35 tons per hour, and requires 3.2 HP. for each 100 ft. of level conveyor. Note that it is 3.2 HP. regardless of whether the output is 10 tons or 35 tons per hour!

The scarcity of data and the apparent unreliability of some of the data given form the most disappointing feature of this volume. Another disappointment in store for the purchaser who counts upon gathering hints on the design of plants is the absence of dimensions in the line drawings. There are many otherwise good illustrations whose value is greatly reduced by the absence of dimensions.

Having indicated, in a general way, what the book does not contain, we pass to what it does contain. A list of the chapters and the pages in each chapter is as follows:

Elevators: bucket elevators, worm elevators, cable, chain elevators, single-bucket elevators, furnace elevators, 30 pages.
Worm Conveyors; 10 pages.
Scraper Conveyors; 12 pages.
Band (Belt) Conveyors; 14 pages.
Metal Band Conveyors; 3 pages.
Picking Belts or Tables; 3 pages.
Traveling Trough Conveyors; 2 pages.
Vibrating Trough Conveyors; 11 pages.
Driving Power for Different Conveyors and Cost of Wear and Tear; 2 pages.
Tilting Bucket Conveyors; 14 pages.
Pneumatic Elevators and Conveyors for Grain; 10 pages.
Special Conveyors: for timber; for hot coke; for molten metal (casting machines); for molten slag; 36 pages.
Endless Chain and Rope Haulage; 6 pages.
Ropeways and Cableways; 76 pages.
Grab Buckets; 21 pages.
Elevators for Unloading Vessels; 18 pages.
Self-trimming Barges; 6 pages.
Dump Cars (also unloading plows); 20 pages.
Unloading by Coal Tips (or tipples); 52 pages.
Colliery Tipplers; 5 pages.
Miscellaneous Loading and Unloading Devices; 17 pages.
Automatic Weighing Machines; 28 pages.
Coaling of Railway Engines; 5 pages.
Coal Handling Plants; 20 pages.
Floor and Silo Warehouses for Grain; 40 pages.
Coal Stores and Silos; 3 pages.
Cantilever Cranes; 30 pages.

There are 542 illustrations in this book, and, without resorting to actual measurements, we estimate that they occupy nearly half of the pages of the book. The author's method of writing appears to have been to select illustrations of a given machine or plant and compile enough text to describe the principal features. Then the different descriptions have been classified under the headings above given. This method, when carried out with good judgment and with thoroughness, will result in a good book of reference, particularly if the author's sources of information are cited for every plant and machine described. Unfortunately for the reader, the author has omitted to cite many of his sources of information, and has concealed many others by such language as this:

The following extract from a paper read by Mr. Charles Claude Carpenter, M. Inst. C. E., shows, etc.

Read when? Read where? There are some subjects that can be so fully treated in a book that the references to original papers would add little to the value of the book; but a book so encyclopaedic as this would be greatly improved by citations of volume, year and page of every quotation and abstract from the technical press.

The great number of abstracts from articles and papers made by the author has been no slight task; and the abstracts, as far as they go, appear to be good. Enough is said in every case to give a clear idea of what each device or plant is like and how it operates. The book, therefore, should prove of great assistance to anyone who wishes a general survey of the field of mechanical transportation, as practiced in England and Europe, and it will occasionally give a valuable hint to one who is selecting or designing a plant.

The author rarely attempts a comparison of the different devices for handling materials, but contents himself with describing each device briefly. Nor does he give enough information to enable the reader to make his own comparisons with any degree of satisfaction.

By looking over the list of subjects given above and the pages devoted to each, one may form some idea of the sketchy treatment that most of the subjects have received. It will be noted, however, that the following subjects have more than the average amount of space: Ropeways and Cableways, Unloading by Coal Tips, Automatic Weighing Machines, Floor and Silo Warehouses, Cantilever Cranes.

More than half the space allotted to Ropeways and Cableways, however, is occupied with photographs, and there are a few line drawings. This leaves little room for text, and that little is mostly descriptive of different installations. The chapter on "Unloading by Means of Coal Tips" describes various devices for dumping freight cars. All but two of the plants shown are English or Continental.

The chapter on "Automatic Weighing Machines" is, like the other chapters, descriptive of devices, and among them we find not one American machine.

If the author is to be criticized for the scant space given throughout his book to American practice, perhaps the most severe criticism is due him for his chapter on grain warehouses and elevators, particularly in view of the fact that he is careful to concede that to America belongs the credit for the design and construction of the greatest grain elevators in the world. Not a single American plant is illustrated.

In the chapter on "Cantilever Cranes" the author again acknowledges indebtedness to American engineers, and this time he illustrates a number of American machines, such as the Brown cantilever crane, the McMyler crane, and one of the Hunt cranes.

The reader will probably have come to the conclusion that this book is largely descriptive of English and Continental machines and plants for handling materials, and in this conclusion he will be right. The reader also may have noted that the author has omitted to describe many appliances, among which are the following: Derricks, Industrial Railways, Tailrope Haulage, Gravity Inclines, Hoisting from Mines, Electric Railways, Electric Telphers, Power Scrapers (other than grain scoops), Dredges and Steam Shovels (other than clam shells), Electric Cranes (such as are used in factories), Locomotive Cranes (one is shown), Trench Excavators and Trench Machines, Pneumatic Package Conveyors, etc. These are mentioned because the title of the book and the author's preface lead one to expect a complete survey of the field of mechanical loading and transportation.

A Laboratory Manual for Experiments with Direct Current Machines.

Reviewed by Henry H. Norris.*

THE TESTING OF CONTINUOUS CURRENT MACHINES IN LABORATORIES AND TEST-ROOMS.—A Practical Work for Students and Engineers. By Charles Kinzbrunner, Assoc. M. Inst. E. E., Lecturer on Electrical Engineering and Design at the Municipal School of Technology, Manchester. New York: John Wiley & Sons. Cloth; 6 × 9 ins.; pp. 326; 249 illustrations in the text. $2.

This work is a laboratory manual giving detailed instruction for carrying out numerous experiments upon direct current machines. The author has had constantly in mind the necessity for planning the exercises with a view to their practical application and has endeavored to make the book useful to engineers as well as to students. The present form of the work is a development from a set of laboratory instructions originally used in the Municipal School of Technology, Manchester, England.

The first section contains general instructions for carrying out experiments and for making and recording observations accurately. It includes descriptions of the auxiliary apparatus used in the operating and testing of electrical machinery. Rheostats, switches, cable terminals and cut-outs are treated in detail with illustrative examples selected from modern practice. The various types of electrical instruments are described, their construction is clearly indicated by numerous drawings and their fields of application are mentioned.

The main body of the work is devoted to explicit and interesting descriptions of 27 well selected experiments covering the following general subjects: measurements of resistance, temperature and speed of machines; production of characteristic curves of dynamo and motor performance; tests of the insulation of machines and of their magnetic properties; determination of efficiency; and separation of losses.

An excellent plan of arrangement is employed in each section for introducing the student to the general topic which is to be illustrated by the experiments. The general principles are first outlined briefly and a summary of the methods usually employed for making the desired measurements is given. The practical application which is made of the tests is also stated so that the experimenter knows the reason for each step taken. These preliminary paragraphs are well illustrated with views of the apparatus and diagrams showing its arrangement. The introductions prepare the student for an intelligent performance of the experiments and greatly enhance the value of the instructions.

In each general class there is a sufficient variety of experiments to enable the students to obtain a knowledge of the relation of the various quantities affecting the performance of the machine under test. The description of each experiment begins with a clear diagram of the necessary wiring and arrangement of apparatus, a convenient system of conventions being employed to simplify the appearance of the diagrams. Then follow the detailed instructions, showing the proper sequence of the parts of the experiment and giving hints as to the best methods of conducting each. Every experiment is illustrated by a record of an actual test and these illustrative examples are accompanied by numerous curves showing the proper form for working up the results, giving reliable data for comparison with the results of the experiments, and pointing out some of the interesting and useful deductions which can be made from them. The actual numerical processes gone through in making these deductions are all given in full so that it is possible for the student to check the accuracy of his work step by step. Many readers will regard these examples as forming the most valuable part of the book, for, not only do they serve the purposes mentioned, but they are interesting and tend to impart vitality to the experimental part of the work by giving a "preview" of what may be expected.

The concluding part of the volume is occupied by material describing commercial tests for acceptance of electrical machines. The report of the Standardization Committee of the American Institute of Electrical Engineers is given in full and in addition the ordinary acceptance tests of the several classes of machines are briefly described. Accompanying these descriptions are copies of the blank forms ordinarily used in connection with such tests.

It is a pleasure to commend Mr. Kinzbrunner's manual to American readers and to state that it deserves to be classed with the somewhat similar works of Nichols, Swenson and Frankenfield, and other well-known writers of electrical laboratory manuals.

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Structural Tables.

OSBORN'S TABLES OF MOMENTS OF INERTIA AND Squares of Radii of Gyration.—To which have been added Tables of the Working Strength of Steel Columns, the Working Strengths of Timber Beams and Columns, Standard Loads and Unit Stresses, and Constants for Determining Stresses in Swing Bridges. Fifth Edition, Revised by The Osborn Engineering Co. (Cleveland, O.). Flexible leather; 4¼ × 6½ ins.; pp. 184; diagrams in the text. $3.

PROPERTIES OF STEEL SECTIONS.—A Reference Book for Structural Engineers and Architects, Including Tables of Moments of Inertia and Radii of Gyration of Built Sections, Examples of Sections Selected from Monumental Structures, Unit Stresses, Safe Loads for Columns, Plate Girder Design, Design in Timber, etc., with Only Sufficient Text to Explain Their Application. By John C. Sample, C. E., M. Arch., Architectural Engineer, New York. New York: McGraw Publishing Co. Cloth; 6¼ × 9½ ins.; pp. 121. $3.

Over a decade ago, Osborn's Tables was a constant companion of most structural steel designers. Three editions were published between 1886, when the book first appeared, and 1894. Since that time the once standard handbook dropped out of use; it had become old-fashioned and offered little help to the designer. The steel shapes (channels and I-beams) represented in its tables of built sections were not the same as the standard market shapes after the middle of the nineties, for about that time the various steel mills agreed upon the famous series of standard shapes which is now in exclusive use in this country. The present or Fifth Edition of Osborn's Tables represents an attempt to modernize the book and make it as useful to the designer as it was fifteen years ago. The principal portion, a collection of tables of Moments of Inertia and squares of Radii of Gyration for a large variety of built-up sections of steel members, has been recomputed, in the main, to suit the standard American steel shapes and modern forms of built sections. An idea of the thoroughness of these tables may be gleaned from the fact that the table for built I-sections (four angles and one plate) covers no less than 371 sections, for each of which the area, the two rectangular moments of inertia, and the squares of the two corresponding radii of gyration are given. The collection of built sections is, however, not quite comprehensive enough to meet all demands; for example, the box-column section (two channels and cover plates, or four angles with side plates and cover plates) is not represented.

This main portion of the book is followed by a long table giving values of L^2 (in feet) ÷ r^2 (in inches), for values of L from 8 ft. to 50 ft. and values of r^2 from 0.1 sq. in. to 120 sq. ins. This table is required because the column formulas, on which are based the tables of working stresses in columns which then follow, are of the Gordon type. Evidently, as no values of r for built sections are given, and no values of L ÷ r, the book is of little service when a straight-line column formula is used. After the tables of column stresses are given: a table of square roots, tables of swing bridge coefficients for shear and moment (for three and four supports, four to twenty panels), tables of rivet values, web-buckling, portal bracing, timber beams and columns, standard bridge loadings, and many other tables. At the end is a brief summary of historical data regarding bridge-building, and a partial table of notable bridge structures of various kinds: steel, masonry, and reinforced concrete.

The book is of handy size and clear typographical make-up, and though it does not meet all the needs of the structural designer in its specific field, it promises to be a useful desk companion and to regain much of its former prestige.

The collection of tables presented by Sample, "with only sufficient text to explain their application," as stated in the title, is related to the well-known "Osborn's Tables" in general covered. An essential difference is that, in the tables of properties of compound sections, Sample gives I and r, while Osburn gives I and r^2. The sections represented are, as might be expected, not the same throughout, which fact renders the two compilations in part supplementary. Thus Sample covers box-column, sections, while Osborn omits these but gives much on bridge chord sections which in turn are poorly represented in Sample's collection. Some tables of safe column loads given by Sample are based on the New York Building Code (15,200 — 58 l ÷ r); these tables are computed directly for the various sections of struts (angle-and-plate, and laced-channel columns). Osborn, on the contrary, gives column loads only as unit loads for different values of l and r^2. Tables of timber columns and beams, and some accessory tables on steel and timber, are also given by Sample. The book will frequently be found a convenient handbook where much designing in steel is to be done. Convenience of reference is somewhat reduced, however, by occasional lack of register where a table extends across the two facing pages, a fault chargeable, of course, to the publisher rather than the author.

Roof Framing.

TREATISE ON MATHEMATICAL AND GRAPHICAL ROOF FRAMING.—For Builders, Carpenters and Iron Workers. By G. D. Inskip. New York: M. C. Clark. Vol. I.: Cloth; 5 × 8¼ ins.; pp. 160; illustrated. $1. Vol. II.: Leather; 8¼ × 3¾ ins.; pp. 326; numerous tables. $1.

These books have been written for builders, carpenters and structural steel designers having roofs to frame. Vol. I. contains many line drawings of simple and complicated roofs, and the text describes in detail how each problem of framing is solved. Methods of obtaining bevels are given, and also many solutions of problems in angular computation. Among the subjects treated are lengths of rafters and hips; hip, plumb, level, rafter and purlin cuts; roofs with surfaces of different inclinations; dormer, gambrel, octagonal and conical roofs; trusses; principles of arithmetic and plane geometry; projective drawing.

To solve the problems in this book only a knowledge of arithmetic is required, supplemented by the instructions given by the author and by the tables of squares given in Vol. II. These tables give the perfect square of any length up to 150 ft., the length being expressed in feet, inches, and eighths of an inch. Thus the square of 149 ft., 7⅜ ins., is 206295769. This square is the square of the 14363 eighths in 149 ft., 7⅜ ins. The table also gives the squares of feet, inches and tenths of inches. Thus 100 ft. has 9,600 eighths of an inch; and 80 ft. has 960 inches, so that the square of one is the same as that of the other, excepting the position of the decimal point.

For all work in which it is desired to find the length of the hypothenuse, given the base and perpendicular, to the nearest eighth of an inch, these tables will serve; and interpolations can be made for sixteenths, or thirty-seconds, with perfect accuracy, since the squares are perfect squares, and not approximations.

In addition to these tables of squares, which occupy 304 pages, there are tables of pitches per foot, and tables of angular ratio (sines and cosines) for every minute of arc up to 90°.

These volumes were published privately a number of years ago, but do not appear to have been brought very prominently before the public until recently. They appear to contain much information of value to those engaged in roof framing.

THE MANUAL OF STATISTICS.—Stock Exchange Handbook, 1905. Twenty-seventh Annual Issue. Railroad Securities, Industrial Securities, Government Securities, Stock Exchange Quotations, Mining, Grain and Provisions, Cotton, Money, Bank and Trust Companies. New York: The Manual of Statistics Co., 25 West Broadway. Cloth; 5½ × 8 ins.; pp. 1040; tables and folding maps. $5.

The aim of this Manual seems to be to bring into one volume the leading items of interest regarding railway and industrial companies whose securities cut a figure in the principal stock exchanges of the country, and to supplement this with the other information indicated in the subtitle. The result is a convenient reference book.

Earth and Rock Excavation.

Reviewed by Daniel J. Hauer.*

EARTH AND ROCK EXCAVATION.—A Practical Treatise. By Charles Prelini, C. E., Author of "Tunnelling." New York: D. Van Nostrand Co. London: Crosby Lockwood & Son. Cloth; 6¼ × 9¼ ins.; pp. 167 figures in the text; $3 net.

Mr. Prelini has given us a book on a much neglected subject in engineering literature, and it is one that should find a place in every engineer's library, while contractors will find many things of value in it. Although the author has given some cost data, yet his book is not meant as a discussion of the cost of various methods of making earth and rock excavation, but rather of the planning and modes of executing both large and small jobs of excavation. The student of engineering will find this book an immense aid towards making him familiar with the different methods of performing excavation before his college days are over. Every technical school should use Prelini's treatise as a text-book, or else require the students to read it as a supplement to their studies. For a technical treatise, the author has handled his subject well, and has written in an attractive style. He seems to be an enthusiast on his work and profession, and has thrown much of his own spirit into the text.

In the first part of the book the author has discussed the plans and profiles necessary for various kinds of excavating work, and has followed this with a most excellent digest of the methods of calculating quantities, with which every student should be conversant. The European custom of making up a working profile of masses is also described. Haul and overhaul are reviewed at some length, especially in reference to the distribution of the excavated material along the profile.

Various small and large tools used in this country and Europe are given seven chapters. Their many uses are set forth, and some data as to the amount of work that can be accomplished with each are presented. Cuts of many tools are given. Those of large machines seem to be from plates furnished by the respective manufacturers of the machines, and are in most cases fair pictures of the tools they are to represent, but it is to be regretted that in many cases the cuts of smaller tools are poor ones, and very unlike modern tools of the same kind used in this country. The greater part of these chapters are both useful and valuable, but the writer believes that many experienced engineers and contractors will differ from Mr. Prelini in the amount of work to be accomplished with some of the tools mentioned. For instance, a man working ten hours a day drilling in calcareous rock and sandstone can hardly drill from 30 to 50 lin. ft. of hole. Nor are many stone sledges, weighing from 30 to 50 lbs. each, wielded by laborers in this country in breaking rock. But there is so much that is really good in these chapters that such minor defects need hardly be noticed, except that, since the book is meant primarily for the student, he is likely to be misled by such statements.

In writing of the use of the ordinary shovel the author speaks of the favoritism shown by contractors in the United States to the short-handled shovel, and of the prejudice against the long-handled shovel, which he says is favored in Europe. He states that he has never had a valid reason given him for this preference, and says that in this country a fair day's work for a man with a short-handled shovel is to load from 7 to 8 cu. yds. into a cart, while European engineers count on 15 cu. yds. being loaded with a long-handled shovel. This is certainly worthy of consideration by American contractors.

Several chapters are devoted to explosives, their compositions, uses, care and earth-moving qualities. But little that is new is given, yet for all that these chapters are valuable, extremely so to the young engineer, while a contractor and experienced engineers can derive much benefit from them. Contractors would do well to instruct their foremen in some of the properties of explosives as set forth by Mr. Prelini.

About forty per cent. of the book is taken up with the hauling or transportation of excavated material, and there has never, so far as the reviewer is aware, appeared in print as much information on the subject, nor has it been presented in as masterly a manner. If the volume contained nothing else, it would be of value for this one subject. When excavation is made by hand the hauling is important, but the picking and shoveling amounts to more in cost; but nothing is so important as the hauling when machines are used, as the hauling is one of the large cost items, both in labor and plant, and if the material is not carried away promptly the machine must stop work. Consequently, excavation becomes a matter of transporting the excavated materials. Mr. Prelini goes into the matter in detail and at great length, and discusses the subject under four heads:

(1) When the earth is hauled on horizontal roads or roads having only a small gradient.

(2) When the roads are very steep, and consequently the materials must be hauled along inclines.

(3) When the materials are hauled in a vertical direction or hoisted.

(4) When the materials, instead of being transported on roads laid on the ground surface, are hauled on roads suspended in the air.

These embrace all known means of hauling; by man power, animal power and mechanical power. Also the use of wheelbarrows, push carts, wagons, carts, stoneboats, scrapers and cars. The operation of railroads, inclined roads, conveyors, elevators, derricks, cranes, cableways, transporters and telpherage. The descriptions are minute, and his discussions are carried on more or less from both a contractor's and engineer's point of view.

The author also compares animal and mechanical labor, and makes some remarks regarding the paying of wages for laborers that differ much from views of the American contractor.

The last part of the book is taken up with a discussion of how to plan and direct the work of excavating, and some condensed descriptions of some of the largest modern engineering undertakings of excavation. These are accounts of canal work, and, of course, include the work done and to be done at Panama.

In considering the treatise as a whole, it is certainly to be commended, as the book will not only be useful to the student, but also to contractors and the engineering profession.

The tables of cost data cannot be used as guides for the cost of similar work, as they are wholly theoretical, and are either based on the wrong assumption of cost or else on the amount of work that can be done in a day. The author also points out that these tables are incomplete, as plant charges, superintendence, and so on, are omitted. Notwithstanding these and the other defects mentioned, the book should find a ready welcome in the engineering world.

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METALLURGIE GENERALE.—Procédés Métallurgiques et Etude des Métaux. By U. Le Verrier, Ingénieur en chef des Mines, Professor at the Conservatoire des Arts et Métiers. In Encyclopédie Industrielle. Paris: Gauthier-Villars. Paper; 6½ × 10 ins.; pp. 403; many text illustrations. 12 fr.; American price, $3.60.

The first chapter deals with the sampling (by hand or machine), separation and briquetting of ores, and is followed by the processes of calcining and smelting, with descriptions of a great number of smelting furnaces, blast furnaces and reducing furnaces for ores of different kinds. Electrical treatment is also described at some length, together with the chemical changes accompanying the treatment by heat and by electricity. The ventilation of metallurgical works, the recovery of blast-furnace dust and the utilization of blast-furnace gas are briefly considered, and then follows a chapter on mechanical equipment; this includes apparatus for handling ore and coal, charging blast and open-hearth furnaces, slag conveyors, ingot casting tables, etc. The second part of the book commences with descriptions of a number of testing machines for tensile tests, and also for bending, punching, compression, etc., including drop and impact testing machines, the effect of heating, cooling and tempering upon the strength of metals. A specially interesting chapter deals with the microscopic and micro-photographic investigations, including the apparatus used and methods employed. The subject of alloys, their properties, their micro-structure, etc., are dealt with in another chapter. The book is very fully illustrated with diagrams, and line drawings of apparatus, while an appendix contains ten plates of microphotographs of various metals and alloys.

LABORATORY NOTES ON PRACTICAL METALLURGY.—Being a Graduated Series of Exercises. Arranged by Walter Macfarlane, F. I. C., Principal of the Metallurgical Department, Staffordshire Education Committee. London, New York and Bombay: Longmans, Green & Co. Cloth; 5 × 7½ ins.; pp. 140; tables, and 29 figures in the text. 80 cts.

In its essential plan this little book is quite similar to Howe's "Metallurgical Laboratory Notes," which was reviewed in these columns, Dec. 18, 1902. In both cases the authors have given a series of exercises for the student to perform in the laboratory, with a view to teaching the principles underlying certain of the most important metallurgical phenomena. Howe has given 91 "experiments," and Macfarlane has given 127 "exercises." It is noteworthy that many of these 127 "exercises" are given in our mining engineering schools as part of the laboratory course in assaying. It is also noteworthy that no "exercises" are given to demonstrate the phenomena of iron and steel metallurgy. On the whole, Macfarlane's "exercises" are more elementary than Howe's "experiments," and do not cover so wide a field. However, every teacher of metallurgy will do well to secure a copy of the new book for, even if not used as a text-book, it may serve to suggest experiments for the students to perform.

IMPORTANT BOOKS.

CEMENTS, MORTARS AND CONCRETES, Their Physical Properties, by Myron S. Falk, Ph. D., Instructor in Civil Engineering, Columbia University. Cloth, 6 x 9 inches, 184 pages, price $2.50.

"This is a valuable contribution to American cement literature. It covers almost every kind of test to which concrete can be submitted to ascertain its identical properties as a material of construction. The text is clear, lucid and to the point. The book should be in the hands of all engineers engaged in concrete construction."—Journal Western Society Engineers.

ROCK EXCAVATION—METHODS AND COST, by Halbert P. Gillette, Author of "Earthwork and Its Cost." Cloth, 5 x 7⅛ inches, 384 pages, price $3.00.

"A book of great importance to contractors, written in an attractive manner, presenting a wide range of information as to actual costs of the details of rock excavation."—Dirt Mover.

EARTHWORK AND ITS COST, by Halbert P. Gillette. Cloth, 5 x 7¼ inches, 250 pages, price $2.00.

TABLES OF SQUARES AND LOGARITHMS, by G. D. Inskip. Containing Tables of Squares from Zero to 60 feet by 16ths. of an inch, Logarithms of 32ds. from Zero to 60 feet, Sines, Tangents, etc. For Engineers, Architects, Draftsmen Flexible Leather, tape bound, 5½ x 7 inches, 208 pages, price $2.50. The most convenient book of squares and logarithms yet published. The typography, presswork and binding superior to anything on the market.

TABLES FOR ROOF FRAMING, ETC., by G. D. Inskip. Giving PERFECT SQUARES of feet, inches and 32ds. to 50 feet and 16ths. to 100 feet. also LOGARITHMS of 32ds. to Zero to 60 feet, Sines, Tangents, etc. Morocco, 6 x 7¼ inches, 448 pages, price $3.00.

MATHEMATICAL AND GRAPHICAL ROOF FRAMING, by G. D. Inskip, in two volumes. Vol. 1: Text, cloth, 5 x 8 inches, 160 pages, price $1.00. Vol. 2: Tables of Reductions and Squares from Zero to 150 feet by 8ths. and to 120 feet by 10ths., also Natural Sines and Co-sines and Table of Pitches per foot; leather, 4 x 8 inches, 326 pages, price $1.00.

MATHEMATICS OF THE PAPER LOCATION OF A RAILROAD, by Prof. J. C. L. Fish, Stanford University. Pamphlet 4½ x 7½ inches, 18 pages, price 25 cents.

The above or any other books on the market can be supplied promptly by **M. C. CLARK,** Publisher and Bookseller, 21 Park Row, New York

Steam Pipes.

Reviewed by Chas. K. Stearns,* M. Am. Soc. M. E.

STEAM PIPES: THEIR DESIGN AND CONSTRUCTION.—A Treatise of the Principles of Steam Conveyance and Means and Materials Employed in Practice to Secure Economy, Efficiency and Safety. By William H. Booth, M. Am. Soc. C. E., Author of "Liquid Fuel and its Combustion." New York: The Norman W. Henley Publishing Co. Cloth; 5½ x 8¼ ins.; pp. 187; tables, and 62 figures in the text. $2.

This book, taken as a whole, is a compilation of various formulas and tables having to do with steam piping, together with such individual practice or designs as have been adopted by several large English corporations or manufacturers. These standards or designs differ one from the other, and could be considered of value only as showing comparative dimensions. The author does not attempt to give any but English practice, and the book would not necessarily meet the exact demands of American Engineers.

In the chapters on "flow of steam, etc," a large number of formulas are quoted, with very little comment as to their adaptability to actual practice, the reader being left to form his own opinion. Two tables, on pages 13 and 21, are given for the equivalent lengths of straight pipe, due to the use of globe valves or elbows, and the results differ so widely that the reader is inclined to be in doubt as to which represents record results.

The velocity of flow considered by the author is 5,100 to 6,600 ft. per min. This is undeniably good practice, but nothing is said as to the high velocities of 8,000 to 12,000 ft. which exist in some of our large modern American power stations.

The reviewer believes comparatively few American engineers would care to specify cast iron for steam mains, even up to 100 lbs. gage pressure, which the author gives as his limit, but we do use cast iron for elbows, tees, etc., even with higher pressures. It is true that cast iron is largely used here in exhaust work, but it is also true that lighter spiral riveted pipe is very largely used in large installations. Cast iron standard lengths of pipe are referred to as 9 ft. for all sizes over 3 ins. in diameter, while American practice is 9 ft. for 2 ins. and under, with 12 ft. for sizes above this. The statement that cast iron elbows should not be used because of the risk of placing a light fitting in a high pressure line is hardly a sound argument, as any competent steam fitter, such as are employed to erect high pressure work, would detect a light fitting before it had been erected. Between the fitters and competent engineer-inspectors the chances of passing a light fitting would be small indeed.

In the chapter dealing with flanges and joints, no distinction is apparently made between high and low pressure work, and the latest and best improved methods are entirely omitted. Standards for diameters of flange drilling, etc., have been adopted in the United States for some little time, both for high and low pressure work, and can always be purchased by specifying which is desired, while our British brethren have as yet to adopt some standard. Forged steel flanges are welded from the best open hearth steel and put on in many cases according to the service they have to undergo: drilling, peaning the pipe over the flange, expanding into recess, welding, shrinking, etc. As the joints, flanges, etc., are one of the most important parts of a system, it would have been well if the author had seen fit to enlighten us as to the best modern English practice in these particulars.

The question of water hammer seems to have caused the author considerable trouble, but with a well-drained system, using modern methods of draining the condensation, this trouble would not occur, and it might have been well to have gone a little further into this subject and given an explanation of modern English methods of returning condensation to the boilers.

Although it is not a standard practice in this country, the plan of having the outlet of tees one-half the length of the run for the same diameter of pipe and various diameters of outlet would be of great advantage to the designing engineer. Copper bends have been almost entirely replaced with wrought iron or steel bends, except for hot water work, in this country.

The empirical formulas of lengths of tubes in right angle bends are very good, also illustrations of the various bends and several extensions. It would be very difficult in practice to set boilers absolutely to dimensions, and good practice in this country always considers a distant piece or "make-up" piece, as the author calls it.

The practice of straining pieces where cold to help take up for expansion when hot is open to considerable discussion, and the reviewer believes engineers would not, as a rule, advocate wedging pipes in a wall to take up partial vibration.

The methods given of supporting pipes do not compare with the modern American practice. The practice of boiling all bolts, etc., in soda before erection of work commences is undeniably good, but rarely possible. Russia iron covering over pipe covering is also good, but exceedingly expensive; canvas neatly painted with fireproof paint is sufficient for all ordinary work.

The quotation from Briggs on bolts, stress, and the table for the same is good.

It is interesting to note what English practice is; but for the American engineer the perusal of the book, considering that the title seems to promise well, leaves a keen sense of disappointment, and a feeling that little of value has been added to our scanty knowledge of steam piping.

Engineering Education.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION.—Proceedings of the Twelfth Annual Meeting held in St. Louis, Mo., September 1-3, 1904. Volume XII. Edited by C. Frank Allen, Fred. W. McNair, Milo S. Ketchum, Committee. New York: Engineering News Publishing Co. Cloth; 6 x 9 ins.; pp. 253. $2.50.

The round dozen annual reports issued by this society more than justify its existence, although they are only a partial indication of its usefulness. Several of the contributors to the present volume express themselves interestingly and for the most part adversely on ideas advanced by Mr. J. A. L. Waddell on extending the work of the society and on increasing the requirements of engineering schools. The leading participants in the two lines of discussion are Prof. Robert Fletcher, in his paper on "A Practical Method of Instructing Engineering Students in the Biography and History of their Profession," and President Alexander C. Humphreys in a paper entitled "The Crowding of the Curriculum."

Among the other interesting papers are: "The Outlook for Engineering Education," by Prof. C. Frank Allen; "The Extension of Engineering Investigational Work by Engineering Schools," by Prof. Arthur N. Talbot; "Industrial Catalogue Library," by Prof. John G. D. Mack; "Report of Committee on Requirements for Graduation," by Prof. W. G. Raymond, Chairman; "Field Work in Civil Engineering at Iowa State College," by Prof. Anson Marston; "The Naval Academy as a Technical School," by Prof. Ira. N. Hollis.

The need of an editing committee is shown in a paper on "The Preparation of Engineering Text-Books," which in the main is wholly unobjectionable and highly interesting, but which contains overmuch of advertising matter for one of the several correspondence schools which are now doing so much good work. This paper, it may be added, contains one surprising statement. In describing two ways of preparing text-books, by outside writers and by writers in the direct employ of the correspondence school, the author says that where the latter method is employed the writer is a person "already somewhat familiar with the subject, who looks up the available authorities and spends considerable time reading, studying and thinking over the subject before writing." Comment might seem to be superfluous, but in fairness it should be remembered that the requirements of correspondence school text-books differ in many respects from other text-books; that there are obvious advantages in having them prepared by a person intimately familiar with those requirements; and that before publication such texts, at least in the case of some schools, are revised by "experts" in the branches of engineering concerned.

*Mechanical and Electrical Engineer, 93 Federal St., Boston, Mass.

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This is the most complete and authoritative treatise on Concrete that has yet appeared.
"The Engineering and Mining Journal,"
May 25, 1905.

An alphabetical index with many cross references closes a book which is—of the many already published on this subject—the amplest, the most exhaustive, and one which will prove invaluable to the widest numbers of readers, both practical and technical.
"Railway Age,"
May 5, 1905.

The authors and publishers have received over a hundred letters concurring in the endorsements given above. These letters have come from Professors in Engineering Schools, and from Water Works, City and Railroad Engineers.

NEW YORK
JOHN WILEY & SONS
LONDON: CHAPMAN & HALL, LIMITED
1905

Radio-Activity.

RADIO-ACTIVITY.—By E. Rutherford, D. Sc., F. R. S., F. R. S. C., MacDonald Professor of Physics, McGill University, Montreal. Cambridge: The University Press. New York: The Macmillan Co. Cloth; 5½ × 8½ ins.; pp. 389; 60 figures, mostly in the text. 10s. 6d.; American price, $3.50 net.

THE NEW KNOWLEDGE.—A Popular Account of the New Physics and the New Chemistry in Their Relation to the New Theory of Matter. By Robert Kennedy Duncan, Professor of Chemistry in Washington and Jefferson College. New York: A. S. Barnes & Co. Cloth; 5½ × 8½ ins.; pp. 283; 54 figures in the text. $2 net.

We confess to much hesitation in grouping under one head two books so dissimilar as are Rutherford's "Radio-Activity" and Duncan's "The New Knowledge." The one is a serious and excellent scientific monograph on Radio-activity, the other is an impressionistic survey of the Periodic System, radio-activity, comet's tails, and other things, written in a style which is "popular" in every respect. But there is, for our purposes, a sufficient tie between the two in the fact that both books center around the past ten years' work on radium and the phenomena of radio-activity; both books speak of the wonderful radiations—emissions of energy—which are observed in great intensity in some materials that are extremely rare and difficult to isolate, and in exceedingly weak form in very many places on the earth, even in the air of our cellars; and both books may individually serve to give some glimpse of the epoch-making discoveries that have made the world's physical laboratories as radio-active as the materials they dealt with. The subject of these discoveries and studies has no ponderable bearing on engineering work, it is true; neither the steam-engine, nor the reservoir wall, nor the railway train, is, or for many years will be, even remotely affected by it. But the engineer, as an educated man and (in the abstract) a dealer in applied science, ought by all means maintain a general acquaintance with the methods and purposes of pure science. Above all, he should at the present time, when discoveries and observations are being made which will undoubtedly reform all our conceptions of the world's physical make-up, take the opportunity offered to get a summarized view, however hasty, of the results hitherto reached in the progress of these observations. Either of the books here noted may serve to give such a view, though in radically different manner.

Professor Rutherford's treatise, the work of a leader in the study of radio-activity, a scientist who placed many of the stones in the towering structure of radio-active hypothesis, recommends itself, by its authorship alone, to those who desire a thorough and scholarly presentation of the subject. It presents, as the author prefaces,

> a complete and connected account, from a physical standpoint, of the properties possessed by the naturally radio-active bodies.

The attractions of its thorough and logical make-up are enhanced by a very simple and therefore forcible and excellent language, the language that we find and admire in the best scientific classics.

But if we have called the style logical and simple, we do not imply that the work is "easy" reading. The exceeding complexity of the phenomena described therein is itself sufficient to demand highly attentive and thoughtful reading. There are, also, occasional mathematical passages, but these are short and infrequent, and only few are essential to an understanding of the development of the text. A far more important matter, in calling for exercise of thought and memory in reading the book, is the explanatory hypothesis which the author advances and which forms the basis of much of the later chapters—the hypothesis of atomic disintegration. The hypothesis explains and clears a large part of the confused complex of phenomena; but at the same time, since it breaks to pieces our first teaching in physical science, the indestructibility of matter, it makes necessary a considerable amount of mental repair-work to re-establish the structure of theory on which the mind bases its thinking in matters of physics.

The contents of Professor Rutherford's book may, thanks to their logic of arrangement, be summarized in brief, despite the complexity of the subject. Following the discovery of X-rays, much work was done in the study of fluorescence, photographic action through light-tight envelopes, and the like. This was the work which led to the isolation of radium and the systematic study of the new radiations. Many substances were found which exhibited radiations not known before; and a considerable number of different radiations and radio-active gaseous emanations was discovered and studied. A brief summary of the course of this study is given in Chapter I. (28 pp.) It is found that all radio-activity is intimately connected with the power of the new radiations to carry electricity away from charged bodies; in fact, the most delicate detector and meter of radiation is based on this phenomenon. This action is parallel to, or identical with, the general action of electric conduction in gases, which in turn is so far analogous to electrolytic conduction that the same term, ions, is applied to the carriers of electric charge in both cases. The theory which has been built up to account for gaseous conduction, the ionization theory of gases, is the subject of Chapter II. (39 pp.), which supplies the concepts needed for readily following the subsequent development. In Chapter III. (23 pp.), Methods of Measurement are discussed, mainly the electroscope and the electrometer. The nature and properties of the various observed radiations are then systematically discussed in Chapters IV. to VI. (111 pp.), together with the question of the energy which is manifested in the radiations. In the next chapter, Continuous Production of Radio-active Matter (19 pp.), is presented the groundwork of observation which leads to and supports the atomic disintegration theory. It is found that various radio-active substances may have their radio-active part completely separated from them, but that they will regain their full radio-activity while the separated portion loses it. It is inferred that the substance must be producing its radio-active matter from its own substance, an inference which is supported by the quantitative course of the change. Atomic disintegration at once suggests itself, particularly as it affords a source for the energy which the radiations carry away. Further complexity is introduced by the "emanations" which pass away from radio-active bodies, emanations which are apparently either gaseous or dust-like, which can excite radio-activity in other bodies, and which are of course totally distinct from the original substance and from the radiations themselves. Chapters VIII. and IX. (96 pp.) deal mainly with these emanations, in systematic account. Finally, in Chapter X., Radio-active Processes (58 pp.), the whole chain of phenomena previously described is brought together for explanation by the author's atomic disintegration hypothesis. Here are also presented some of the speculative reconnaissances which the phenomena and the hypothesis lead to. A closing chapter of 32 pages is added, in which the various recorded observations of radio-activity in the atmosphere and in ordinary materials are summarized.

The book as a whole is satisfying and stimulating in unusual degree. It has value not merely as a present-day view of the subject, but also as a permanent reference treatise on the work done up to the present in the field of radio-activity. It is primarily an account of observations, and is but little tinged with theory or biased view.

The writing of Professor Duncan is radically different in character. It is avowedly for the lay reader, for the man who desires something intermediate between illustrated-magazine science and the scientific treatise. There is much evident enthusiasm behind it. The style outflammarions Flammarion in its vividness and its occasional verse quotations. So also is its all-embracing scope an expression of the author's literary enthusiasm rather than of his scientific earnestness. He has gathered into his pages every hypothesis or speculation of recent years that seemed to fit into the dramatic picture: Kelvin's electrical explanation of mechanical inertia, Lockyer's ideas of cosmical changes, the origin and interconvertibility of matter, the nature of the ether, possible commercial energy-production by smashing atoms into dead dust, and so on; and he manages to end up with the orthodox sentiment: "Meanwhile we feel that we know this, 'In the beginning God created.'". Yet with all the "popularity" of the style there is a good though elementary and sketchy account of what has been observed and measured in the magic field of radio-activity. This account, which forms the central and essential feature of the book, has the merit, as compared with a book like that of Professor Rutherford, of making but a minimum demand on the reader's mental concentration.

There is a special merit, besides, in a condensed and simplified account of the complex chain of radio-active phenomena as is given by Professor Duncan. The framework of the evolved theory is left more bare and unconcealed when the subject is thus freed of detail and complexity; the thin legs of assumption or mathematical premise which support it may be more readily found by the careful reader. In consequence a somewhat sounder view of the whole field of work is obtained than when the reader ingests in one undifferentiated mass the observed phenomena, the hypothesis, and the calculations which prove it. The reader becomes more fully conscious of the Munchhausen-like leap which the scientist makes from the firm footing of the radioscope to the cannon-ball of the negative electron, of the merry confusion, in a single course of calculation, between solid spherical atoms and planetary-system atoms, and other features of the theoretical structure.

Both of the books here noted address themselves to the readers of these pages. According to the temperament of the individual, one or the other book will be the proper choice; the remarks above are intended to give some guidance for this choice. Either book may serve for obtaining a view of the work accomplished and the trend of the study of radio-activity. And, as said above, we hold that every educated person, especially every engineer, owes it to himself that he keep informed of the epoch-making development of this study, at least to the extent of reading a brief summary of the work of a decade, such as is given in the two books noted.

REPORT OF COMMITTEE ON STANDARD METHODS OF WATER ANALYSIS

to the Laboratory Section of the American Public Health Association. Presented at the Havana Meeting, January 9, 1905.

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CHICAGO, ILLINOIS

DIFFERENTIAL EQUATIONS.—A Short Course for Engineering Students. By James E. Boyd. Columbus, Ohio: The Author (Ohio State University). Cloth; 5¼ × 8 ins.; pp. 54. 60 cts.

The study of differential equations is one of those parts of the calculus which, through press of other matter, can be given but little attention in the engineering courses of technical colleges. In many cases, indeed, nothing whatever is said of differential equations, and the nascent engineer ends his brief mathematical course with the vague impression that $dy \div dx$ must equal something or else the problem cannot be solved. Later, in the study of beams and columns, electric currents, etc., simple forms of differential equations present themselves, and their solution is detailed in the text-books. For all further knowledge of differential equations the student must rely upon subsequent self-study. The little book of Professor Boyd is well adapted to serve as a basis for such study. It is clear in its exposition, gives many examples of both the mathematical and the applied kind, and above all is small and inexpensive. It might be suggested that an appended summary of typical forms of differential equations, with references to the book itself for those treated and references to other works for more complex forms or those which lead to special branches of mathematics, would prove a helpful feature in many cases.

Building Inspectors' and Constructors' Handbook.

Reviewed by Wm. W. Ewing,* C. E.

A HANDBOOK FOR SUPERINTENDENTS OF CONSTRUCTION, ARCHITECTS, BUILDERS AND BUILDING INSPECTORS.—By H. G. Richey, Superintendent of Construction, U. S. Public Buildings; Author of "Richey's Guide and Assistant for Carpenters and Mechanics." New York: John Wiley & Sons. London: Chapman & Hall, Ltd. Morocco; 4 × 7 ins.; pp. 744; 357 figures and many tables in the text. $4.00.

As indicated by its title, this book treats in general of such subjects as are usually to be found in an architect's hand or pocketbook. Much of its contents is matter already compiled in similar books, but in addition a considerable amount of new matter is given, in the way of data and methods, which makes the book more than a mere duplication of existing handbooks.

Of the subjects which receive particularly thorough and careful treatment are: Excavating, laying out foundations, testing and analysis of stone, stone and bricklaying (which is especially well illustrated), testing of soil, piling, timber specifications, steel sheet piling, building stones, etc. The statistics of building stones, remarks on inspection of granite, and, in fact, all matter on stones and their uses and inspection is excellent.

A fair amount of space is devoted to cement and concrete. Although some parts of this subject are discussed briefly in comparison with others, the section as a whole contains much that is of service to an inspector of such work. The related subject of concrete piles, a new subject in books of this kind, is sufficiently full to explain the relative value of wood and concrete piles. Steel sheet piling, reinforced fireproof floor and column construction, and some similar subjects that have recently become prominent, are discussed and illustrated sufficiently to afford a convenient reference and guide for the inspection of such work. The discussion is, however, not fully representative of the multitude of "systems" or styles of construction in current use.

New matter appears in the sections on riveting, carpentry, grading of lumber, marble mosaic, chimney flue construction, and regulations concerning it. These sections, and a collection of statistics on work in standard cementing materials, will prove of value to the superintendent, the estimator and the inspector.

A description of weir-dam measurement of steam flow is of comparatively little interest to the inspector of building construction. In its stead space might well have been given to describing systems of reinforced concrete building construction in more detail, to the discussion of scientific waterproofing of foundation work, and similar subjects more directly pertinent to building work.

In general, the book is meritorious and well presented, almost all of the matter being of value to building inspectors or superintendents. Due credit is given to the various authors consulted. Numerous quotations from the New York Building Code form a valuable feature of the different sections; a minor error noted in this connection is made in quoting the date of the New York Building Code as 1901, instead of the correct date, 1899. The book compares very well with other books of its kind and will be welcomed by those who desire a compact ready reference with the latest information on subjects of interest to superintendents and inspectors.

DIRECTORY OF AMERICAN CEMENT INDUSTRIES.—Third Edition, Revised and Enlarged. Edited by Charles Carroll Brown, M. Am. Soc. C. E. Indianapolis and New York: Municipal Engineering Co. Cloth; 5½ × 8¼ ins.; pp. 748.

This is the third edition of this valuable directory. It contains brief descriptions of all the cement manufacturing works in America. The number of works manufacturing or proposing to manufacture cement is now 255, an increase of 25% over the number given in the second edition. Among the useful lists in this volume are the following: Cement Manufacturers, Cement Brands, Sales Agents, Dealers in Cement, Contractors and Other Users of Cement, Makers of Artificial Stone and Concrete Blocks, Engineers and Other Supervisors of the Use of Cement, List of Cement Testing Engineers and Laboratories, Plaster Manufacturers, Lime Manufacturers, Dealers in Lime and Plaster. There is a map showing the location of cement plants and a valuable table giving freight rates on cement between different cities.

*Treasurer, The Thos. J. Brady Co., 1123 Broadway, New York City.

The Story of the St. Lawrence River.

THE ST. LAWRENCE RIVER.—Historical, Legendary, Picturesque. By George Waldo Browne. New York and London: G. P. Putnam's Sons. Cloth; 6¼ × 9¾ ins.; pp. 365; many illustrations, and one folding map. $3.50 net.

It is surprising to see how much of the history of some countries may be gathered about their principal rivers. The most notable instance of this is afforded by Egypt and the Nile, but in the early history of North America, and in fact well up to the advent of railways, the principal rivers were the centers of activity and influence in many large sections of country. For nearly two centuries the St. Lawrence River bore this general relation to the settled portions of Canada.

The author of the book before us has told the story of the St. Lawrence and of early Canada in a most interesting manner, as well he might with such a theme and with such narrators as the Jesuits and Parkman as forerunners and examples. The greater part of the volume is devoted to the early discoverers, missionaries, fur traders and voyageuers and their encounters with the Indians, and to the struggles between France and England for the control of Canada. Then follow a number of chapters on the natural attractions of the great river and its tributaries and on the attractions, natural and otherwise, of Quebec, Montreal and lesser Canadian cities. Woven in with the historical and the picturesque, there is, as the subtitle of the book implies, much of legendary interest.

The illustrations with which the book abounds are more eloquent than words in portraying the natural beauties of the St. Lawrence and its great feeders; the subjects are varied and well-chosen and such as are from photographs, as is the case with most of them, show remarkably good photographic work. The engraver's work throughout is excellent and the same adjective may be applied to the manufacture of the book generally.

An engineer would naturally wish for more physical statements regarding the river itself, the few but significant facts under this head in the opening chapter being very inadequate for his purposes; but obviously the book was designed to appeal to no one class of readers and must be judged with that fact in mind. It is natural, though, for many engineers to be particularly interested in a book devoted to an important river, and to welcome an occasional bock that suggests little or nothing of professional work. It may be stated that the Hudson and the Connecticut River have been so treated as to make companion volumes to this one, while classed with the three, although more technical in character, is Frederick S. Dellenbaugh's "Romance of the Colorado River," reviewed in this Supplement for Feb. 19, 1903. In conclusion, the Nile having been mentioned, reference may be made to Miss Amelia B. Edward's "Thousand Miles up the Nile," which though containing not a little Egyptology is full of interest from cover to cover.

DIE NEUBAUTEN DER KOENIGLICH SAECHSISCHEN TECHNISCHEN HOCHSCHULE ZU DRESDEN. Paper; 10 × 13 ins.; pp. 56; 1 folding plate, many text illustrations.

The Royal Technical College of Saxony has, during the past five years, been almost completely rebuilt, as described in detail in the pamphlet here noted. The new buildings comprise: Two mechanical laboratory buildings, with boiler house; a large college building; a building for the Royal Testing Laboratory of Saxony; an electrical laboratory; a central power and heating plant. The entire group of buildings was shown by a model at the St. Louis Exposition last year. The pamphlet describes the buildings and the equipment in considerable detail, the text being abundantly illustrated by drawings and views. An appendix similarly describes the model basin, for marine testing, at Uebigau near Dresden. This basin is the property of a shipping company, but the [illegible] authorities and the Royal Technical Colle[illegible] acquired the right to share in its use. Th[illegible] is about 200 ft. long by 23 ft. wide, and [illegible] deep at the center.

MINISTER OF MINES OF BRITISH COLU[illegible] Report for the year 1904. Victoria, B. C.: [illegible] Paper; 7¼ × 10½ ins.; pp. 319; tables, fold[illegible] other plates, and text figures.

This report is admirable in its concisene[illegible] in the amount of information conveyed as to the mines and mineral resources of British Colu[illegible]. Especially to be commended are the data on hydraulic mining, showing the number of days of "piping" at different placers, the yardage of gravel moved, and the miner's inches of water used. Such information serves as an excellent guide for others contemplating similar operations. If cost data on ore mining operations could be secured in greater detail the report would be of even greater value. It is not necessary that the earnings of mines be published. The detailed costs of developing and working the mines, expressed in dollars per ton mined, can be made of great value, if the local conditions are described in each case.

THE BURNING OF TOWN REFUSE.—With Special Reference to the Destructors at Brussels, West Hartlepool, Moss Side (Manchester), and Westminster. By George Watson, M. I. Mech. E. Excerpt Minutes of Proceedings of the Joint Meeting of The Institution of Mechanical Engineers with The American Society of Mechanical Engineers, in Chicago, June 1, 1904. Westminster, S. W., London, Eng.: The Institution. (The author may be addressed care of Horsfall Destructor Co., Leeds, England.) Paper; 5½ × 8½ ins.; pp. 549 to 590; plate and text figures.

This able and interesting paper was reprinted in Engineering News for June 30, 1904, except for some of the illustrations, a table of tests of the Westminster destructor and the brief discussion which followed the reading of the paper, and which the author subsequently closed by letter.

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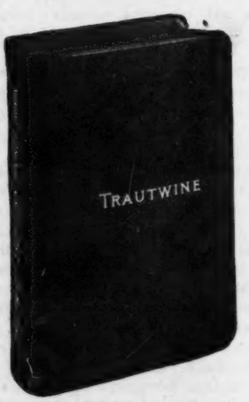

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Centrifugal Fans.

Reviewed by D. W. Taylor.*

CENTRIFUGAL FANS.—A Theoretical and Practical Treatise on Fans for Moving Air in Large Quantities at Comparatively Low Pressures. By J. H. Kinealy, M. Am. Soc. M. E., formerly Professor of Mechanical Engineering at Washington University, St. Louis. New York: Spon & Chamberlain. London: E. & F. N. Spon, Ltd. Leather; 4 × 6¼ ins.; pp. 206; 22 tables and 35 figures in the text. $5, net.

This compact little treatise is devoted mainly to the theory of centrifugal fans. There is included in it, however, a brief outline showing the evolution of the present usual commercial type of centrifugal fan and some practical information concerning the less common types, such as the cone type, running without a casing, and disk or propeller fans. The work is primarily devoted, however, to the ordinary commercial fan for use in heating and ventilating work or for mechanical draught, with six to twelve blades of little or no curvature and with sheet metal housing. Valuable information is given as to the nomenclature of such fans and data for the design of housing for same.

The author's fundamental theory of the action of such fans may be briefly summarized. Consider, first, a fan revolving at a fixed speed in its housing with a tightly shut outlet. The excess pressure in the housing will be that due to a head of air corresponding to the velocity of the tips of the fan wheel. Then if a small opening is made in the casing to allow the air to escape it will escape with the velocity of the fan tips until the opening reaches a certain area, which the author calls the "blast area." Until the area of outlet is equal to the "blast area" the pressure in the fan casing will remain unchanged. When the outlet area is greater than the "blast area" the pressure in the fan casing will be less than that due to the velocity of the blade tips. The amount of air discharged through the "blast area" of the fan, upon the suppositions above, the author calls the capacity of the fan. Upon this fundamental theory he has developed numerous formulae giving the discharge of fans under various conditions, pressures which they will develop, the work they put into the air, the horse power required to run them, efficiencies, etc. There are given very complete tables for the above calculated from the formulae.

The fundamental theory, however, does not adequately cover actual conditions. In practice air leaving a fan usually passes into a discharge pipe. Experiments with such fans as the author deals with show that if the discharge pipe is closed so that no air is passing the pressure in the discharge pipe at the outlet of the fan is slightly greater than that due to the velocity of the blade tips. The reason is obvious. When a fan is revolving in its casing with outlet closed the pressure outside of the blade tips is, as pointed out by the author, that due to the velocity of the blade tips, but further, the air at the blade tips is moving with the velocity of the tips, making the total head double that given by the author. If the kinetic energy of the air leaving the blade tips could be all converted into pressure head, the total pressure of the air at rest in the discharge pipe would be double that due to the velocity of the blade tips. Unfortunately, fans as made are very inefficient instruments for the conversion of velocity into pressure, and, as already stated, experiment shows that when discharging very small quantities of air the pressures at the outlet are but little above those due to the velocity of the blade tips. Furthermore, experiment has demonstrated conclusively that the pressure in the discharge pipe immediately at the outlet of a fan of the type discussed by the author always falls off as the amount of air allowed to pass is increased without changing the revolutions. In other words, in practice the blast area or "hold-up area," as it is sometimes called, is for such fans largely imaginary. It is true that the falling off in pressure is small at first as the discharge of air increases, but for fans discharging anything like their capacity as calculated by the author the pressure in the discharge pipe is far below that due to the blade tip velocity.

The author bases all of his formulae upon the diameter of inlet, the ratio between the diameter of inlet and diameter of the fan wheel and the number of revolutions per minute. Width of blade, number of blades and shape of blades are ignored in the formulae, a proceeding which has justification, however, if we consider that the formulae are intended to be used for fans of a single type. It is difficult to believe that for a fan of given diameter and given number of revolutions, the capacity would be increased 33% by an increase of 10% in diameter of inlet, yet this is the result to which the author's formula for capacity leads us. This formula is

$$C = 1.38\ r^2D^2N,$$

where C is the capacity of the fan in cubic feet per minute, r is the ratio between the diameter of the inlet and the diameter of the runner, D is the diameter of the runner in feet and N the revolutions per minute of the fan.

The formula given by the author for pressure is

$$P = \left[\frac{(D\,N)^2}{1650}\right],$$

where P is pressure in ounces per square inch, D is diameter of the wheel in feet and N the revolutions per minute. Equation 48, on page 92, gives this formula reversed,

$$P = \left[\frac{1650}{(DN)^2}\right],$$

an obvious typographical error. It has already been pointed out that this formula will give somewhat less than the usual pressure at the outlet of a fan such as the author is dealing with when running with a closed outlet, but as the discharge increases the pressure continually falls off, and any formula based upon the assumption that this pressure remains unchanged throughout any material variation of discharge cannot correctly represent the facts.

A large number of tests of fans working with free inlets and discharging into pipes about the size of their outlets against various pressures have been made at the Experimental Model Basin at Washington, and a comparison between the author's formulae and the results of experiments appears to indicate that the formulae largely overestimate fan capacity if the pressure in the fan casing used by the author is taken to be the same as that in the discharge pipe at the outlet, which presumably it should be. A fair typical example is that of a fan of well-known make with inlet 20½ ins. in diameter, impeller 30 ins. in diameter, outlet 18¼ ins. in diameter. By the author's formula for pressure this fan would show a pressure of 1 oz. per. sq. in. at 660 revs. per min. As a matter of fact, when tested discharging into a 20-in. pipe about 44 ft. long and closed at the end the pressure shown at 660 revs. per min. for air at 70° F., with 30 ins. barometer, was about 1.1 ozs., or 10% greater than that by the author's formula. The capacity of this fan by the author's formula would be 4,540 cu. ft. per min., the pressure still remaining at 1 oz. until the capacity is reached. As a matter of fact, at 660 revs. per min. the total discharge of this fan with wide open outlet was about 4,600 cu. ft. through the 44 ft. of pipe, or barely the capacity given by the author, while the pressure at the outlet under these conditions, instead of being 1 oz., was about 0.2-oz., only. The efficiency at this maximum discharge was very low, less than 30%. The maximum efficiency was shown at 2,500 cu. ft. delivery, at which delivery the pressure in the pipe was slightly less than 0.9-oz. Above this discharge the pressure fell off very rapidly, being 0.66-oz. for about 3,200 ft. delivery and 4-9-oz. only for about 3,800 cu. ft. delivery. Comparison between experimental results obtained from a number of fans of various makes and the author's formulae show that, considering pressure in the discharge pipe at the fan outlet, the author's formula for capacity frequently gives double the real capacity of a fan against a pressure due to the blade tip velocity. Results from the formula, however, vary radically as compared with results of experiments, a result probably due to the fact that the formula ascribes entirely too much importance to the inlet area, minor variations in this producing great variations in estimated capacity.

When considering work and efficie... the author falls into a number of errors. He ... s that the work done per minute in moving air ... to the product of the number of cubic feet of a... ed per minute multiplied by the sum of the pr... in the housing near the outlet, and the pressure ... ponding to the velocity per minute of the air as it e... the fan.

If we substitute for "as it enters th... n" the words "as it leaves the tips of the fan ... l," we have a correct definition of the net en... which the air carries away from the fan wh... With fans of the proportions recommended ... the author the velocity of the air as it leave... the fan tips is very much greater than that w... which it enters the fan, and hence his work ... culated in accordance with the above definition ... ould be always materially less than the actual ... work carried off by the air were it not that the pressure which he assumes is greater than the true pressure. The author's erroneous conception of the work done upon the air casts a doubt upon the calculations and formulae which he gives for the horsepower to run a fan, and probably accounts for the statement on page 122: In choosing a motor to run a fan, to assume that the power required would be that "required to run the fan plus a slight loss between the fan and the motor * * * * would mean 'figuring' closer than can be considered good engineering." The author states that he usually installs a motor of a third greater horsepower than that required to run the fan as calculated from his definition of work above. The power absorbed by electric motors driving fans is readily and accurately determined. Engines used for driving fans will often work beyond their designed power without trouble. Not so with motors. An overloaded electric motor is soon heard from.

There is a curious statement on page 115, in discussing the power of engines required to run fans. The author says the efficiency of engines to run fans is usually between two-thirds and three-fourths for engines belted to the fans and from one-half to two-thirds for those direct-connected to the fans. The context shows that the efficiency referred to is the mechanical efficiency of the engine, or the ratio between the brake and indicated horsepower, and one wonders why there is such an invidious discrimination against the efficiency of the direct-connected engine.

The author considers the efficiency of a fan to be the ratio between the useful work and the work required to run it. He considers the useful work, however, to be the product of the quantity of air delivered per minute by the pressure in the housing at the outlet. It would seem obviously necessary to include in the useful work the kinetic energy of the air as it leaves the outlet.

The efficiency of the fan proper, including the efficiency of the housing, could never exceed 50% upon the author's theory, even if there were no losses by friction or eddies in the air before it leaves the blade tips. Under this theory the air is discharged from the runner with a velocity equal to that of the blade tips and against a pressure equivalent to the velocity of the blade tips, the pressure head and kinetic head being equal. If, as the author assumes, it escapes through an opening less than the "blast area" with a velocity equal to that of the blade tips it carries off an amount of energy due to its kinetic head only, or but one-half the total energy with which it left the blade tips, giving a loss of 50% in passing from blade tips to outlet apart from any loss before leaving the blade tips.

The efficiency formula deduced by the author is very simple, being for the type of fan which he recommends when working at its capacity,

$$e = \frac{0.9}{1+r^2},$$

where e is efficiency and r is ratio between the diameter of inlet and diameter of runner. The smaller the inlet the greater the efficiency by this formula, and for an inlet one-half the diameter of the runner the efficiency is 72%; that is to say, for a given size of inlet all we need do to gain efficiency is to increase the diameter of the runner. This is not in accordance with practice and the efficiencies given by the author are materially above those found upon testing actual fans.

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It is difficult to see how this work can be of material value to the practicing engineer. It is much to be regretted that the theory of the operation of centrifugal fans is not so straightforward as assumed by the author. He makes a few comparatively simple basic assumptions and the rest is a mere question of mathematics, which he has handled excellently. Unfortunately a comparison of reliable experiments with the formulae of this work shows conclusively the fundamental assumptions of the author do not adequately cover the operation of fans as they are found in practice.

A British-American Book on Cements.

CALCAREOUS CEMENTS: THEIR NATURE, MANUFACTURE, AND USES.—With Some Observations upon Cement Testing. By Gilbert R. Redgrave, Assoc. Inst. C. E., and Charles Spackman, F. C. S. Second and Revised Edition. London: Charles Griffin & Co., Ltd. (Philadelphia: J. B. Lippincott Co.) Cloth; 6⅝ × 9 ins.; pp. 310; tables, and 63 figures in the text. 15 shillings; American price, $4.50.

In its present edition this book is noteworthy for its discussion of cement manufacture. Over one-third of the space is devoted to this subject. The next largest space is given to composition, chemical analysis and constitution. In these sections and in its historical notes on the development and early manufacture of hydraulic cements the book is superior to any other treatise of which we have knowledge. On the subject of cement testing, however, it falls far behind the recent American books on cements and cement products, and it does not consider at all fully the manufacture and properties of mortars and concrete. The above analysis of its contents defines the limits of utility of the book to the engineer.

In the first edition of the book, Mr. Redgrave devoted unusual space to historical notes on the development of the manufacture and use of cement. The present edition repeats this information and adds considerable new matter mostly in the form of scattered comment and notes. The information is not presented in the shape of a continuous history but as a series of historical notes between which the connection is not very plain. The chapters on composition, chemical analysis and constitution of cements excell those devoted to the same subjects in any of the textbooks with which we are familiar.

There are some chapters on Portland cement manufacture, and through the association of Mr. Spackman, the well-known American authority on the subject, these chapters contain an unusually good exposition of American methods and machinery. The review of the subjects opens properly with a consideration of the selection and analysis of raw materials and their proportioning in compounding the standard raw mixture. Then three chapters which follow describe methods of preparing the raw mixture first by wet methods and second by dry methods. Two chapters relating to methods of calcination follow; the first of these considers the general questions of chemistry and temperatures, and describes stationary kiln practice, and the second describes rotary kilns and their operation. The final chapter on manufacture takes up grinding, storing, packing, etc. There are separate chapters on slag cement and its manufacture, on the manufacture of lime, on the manufacture of plastic cements, and on the manufacture of various special cements, such as Scott's cement and selenitic cement.

EXPERIMENTAL RESEARCHES ON THE CONSTITUTION OF HYDRAULIC MORTARS.—By Henri Le Chatelier. Translated from the Original by Joseph Lathrop Mack. New York: McGraw Publishing Co. Cloth; 6 × 8¼ ins.; pp. 132; one plate and two text figures. $2.

The French edition of this reprint was reviewed in our issue of Feb. 16, 1905, at which time the significance of the investigations of Le Chatelier and the place that they now occupy among studies into the constitution of hydraulic cements, were commented on. So far as the translation is concerned no particular comment is necessary. It is authorized and it has been satisfactorily done. To cement chemists and engineers who do not read French, the essays of the noted Frenchman will be exceedingly welcome in their present form.

The Panama Canal.

PROBLEMS OF THE PANAMA CANAL.—Including Climatology of the Isthmus, Physics and Hydraulics of the River Chagres, Cut at the Continental Divide and Discussion of Plans for the Waterway. By Brig.-Gen. Henry L. Abbot, U. S. Army, Retired. New York: The Macmillan Co. London: Macmillan & Co., Ltd. Cloth; 5¾ × 7¾ ins.; pp. 248; 34 tables, one folding map, and 15 figures in the text. $1.50 net.

The great interest in the Panama Canal enterprize at the present time makes this little book by General Abbot very timely. It will be appreciated by engineers since it discusses the engineering problems presented at Panama, and gives a clear picture of the difficulties to be encountered and of the several plans proposed for overcoming them. It would be difficult to find anywhere one better qualified to discuss the Panama problems than General Abbot. He is the only living American engineer who was a member of the International Commission, organized by the New Panama Canal Co. of France in 1895 to study the engineering problems and report the best plan for a canal at Panama; and his seven years' service on that Commission made him familiar with the entire situation on the Isthmus to a degree equaled, probably, by few even of those engineers who have served on the later American Commissions.

The first five chapters of the book are descriptive of the canal generally; and in the concluding chapter the author describes the rival projects for the canal and strongly defends the plan adopted by the Commission of which he was a member, as compared with the plan favored by the American Isthmian Canal Commission of 1900.

As for the sea-level plan, General Abbot's book was evidently prepared before the recent declarations of Messrs. Parsons, Burr and Wallace in favor of the sea-level plan; but he gives briefly the reasons for the abandonment of De Lesseps' original sea-level plan, and says:

> Why then waste an extra ten or a dozen years and untold millions of dollars to execute a scheme which the investigations of 35 years have demonstrated to possess only a sentimental merit due to the imagination of M. de Lesseps?

We consider it fortunate that General Abbot has been selected as one of the Advisory Commission to report on the best plan to be adopted for the canal, as it makes certain that the merits of the lock project will be thoroughly presented to the Commission; and if a sea-level plan is finally adopted, it will be on its engineering merits and not on mere sentiment.

THE RAPID DETERMINATION OF SULPHATE IN CEMENT.—By Daniel D. Jackson. (Reprinted from The Chemical Engineer, Vol. I., No. 6, April, 1905.) Paper; 6 × 9½ ins.; pp. 363; one figure.

This pamphlet describes briefly the apparatus and method employed for the rapid determination of sulphate in cement at the Mt. Prospect Laboratory of New York City. Except where close determinations are required, the apparatus serves all essential purposes of the sulphate test, and is rapid enough to be practically operated in commercial testing. The method employed is to make a solution of the cement to be tested by the aid of stated chemicals. The solution is poured into a graduated tube, mounted over a fixed candle, until the candle is obscured. A reading of the depth of the solution is then taken, and from this reading the percentage of sulphate is, in turn, read from a table given in the pamphlet.

THE POCKET BOOK OF REFRIGERATION AND ICE-MAKING.—Edited by A. J. Wallis-Tayler, C. E., Assoc. M. Inst. C. E., Author of "Refrigerating and Ice-Making Machinery," "Refrigeration, Cold Storage and Ice-Making," etc., etc. Fourth Edition, Enlarged. New York: The Norman W. Henley Publishing Co. Cloth; 4⅛ × 7 ins.; pp. 184; tables and 31 figures in the text. $1.50.

Readers of this author's large and excellent treatise on "Refrigeration, Cold Storage and Ice-Making" that was reviewed in our issue of Dec. 18, 1902, will recognize the present book as a condensation. Except that the descriptions of refrigerating machines and their development are omitted entirely, the "pocket book" contains in miniature about all that there is in the way of working and test data and exposition of principles in the larger work. There are five chapters in the book, the first being descriptive of refrigerating machinery and methods in general, and the others covering cold storage, ice-making and storing ice, insulation, testing and management of refrigerating machinery, and general tables and memoranda. For superintendents and operators of refrigerating plants and for designing engineers the pocket book contains all in the larger treatise that is ordinarily used, and is for daily use much more convenient in form. It does not, however, replace the larger book in its full and excellent descriptions of refrigerating machines and systems of refrigeration.

RUSSIAN PROVISIONAL FORTIFICATIONS.—A Translation of a Series of Studies on Provisional Fortifications by Russian Officers. From the "Mitteilungen über Gegenstände des Artillerie und Geniewesens." Series of 1904, Parts I., II., III. Translated by First Lieut. Elliott J. Dent, Corps of Engineers, U. S. Army, and First Lieut. George R. Spalding, Corps of Engineers, U. S. Army. Washington Barracks, D. C.: The Engineer School. Paper; 6 × 9 ins.; pp. 42; seven folding plates.

This series of papers upon provisional fortifications by Russian Engineer officers is especially interesting, in view of the present Russian-Japanese War. A number of the fortified places assaulted and taken in and about Port Arthur were protected on the principles here laid down. The salient features, aside from the grand plan fixed by location, are: That all forts are links in a chain of fortifications; that the parapet must withstand the fire of field and siege guns; the living quarters must be bomb-proof; and the approaches must be protected by water, by wire entanglements, by man-pits with sharp stakes in the bottom, etc. The series takes up various forms of forts, their force and armament, their speedy protection and completion, the volume of material to be moved and the number of workmen necessary for their erection. The treatment is terse and technical.

A SHORT STORY OF ISAMBARD K. BRUNEL.—By Dwight Goddard. Worcester, Mass., and Cleveland, O.: Wyman & Gordon. Paper; 4½ × 6¼ ins.; pp. 10; portrait.

The "Short Stories of Engineers" issued by this firm "in place of a catalogue" now include 21 names, among which are Watt, Boulton, Fulton, Stephenson, Nasmyth, Bessemer, Krupp, Ericsson, Eads, Peter Cooper and Benjamin Franklin. The subject of the present sketch was the son of Sir Marc Isambard Brunel, one time State Engineer of New York during a short residence in America, and later noted for his bridge and tunnel work. The son assisted his father, and subsequently was engaged in railway and more particularly in steamship construction, being a pioneer in ocean-going steamships.

L'AEROVOIE.—A practical Solution of the Prob'em of Aerial Navigation. By Dr. Federico Sacco, Professor in the School of Engineers of Turin. Turin, Italy: The Author. Paper; 6¼ × 9½ ins.; pp. 11.

In this pamphlet the author presents arguments for a new form of aerial transportation. The suggestion is to hitch captive balloons to the cars of an ordinary cableway. The line is to be called an "Aërovole" (Latin "Aercovia," Anglice "air road"), and the pamphlet describes its general construction and presents arguments in support of its economic practicability and utility.

HIGHWAYS: INSTRUCTIONS AND FORMS.—Bulletin No. 1, Highway Department, State of Ohio. Prepared by Sam Huston, Commissioner. Columbus, O.: Pub. Doc. Paper; 6½ × 9½ ins.; pp. 16.

This bulletin gives the "good roads law" of Ohio, also forms for petitions for road improvement, resolutions appropriating money, etc.

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Literary Magazines.

"The Piercing of the Simplon" is the subject of a paper in the June "Century," and the story of the driving of the longest railway tunnel in the world is very well told. It may be remarked here, however, that while the Simplon is the longest railway tunnel and the longest tunnel ever driven from the two portals without intermediate shafts, it is really far inferior in length to the New Croton Aqueduct tunnel of the New York Water Supply, which is about 40 miles in length. The 12¼-mile tunnel beneath the Simplon pass was begun on Nov. 13, 1898, and the headings from the Swiss and the Italian sides met on Feb. 24, 1905. The "Century" article, although popular rather than technical, appears to be fairly accurate. We notice only one statement that will cause an engineer to raise his eyebrows. We quote this as follows:

> One of the first surprises produced by the rotation of the hydraulic drill was in the difference between the experimental and the actual phases of the daily advance. In formulating the contract, a large piece of rock had been taken to Winterthur, where it was shown by the operation of the drill that it could be pierced at the rate of a yard in from twelve to fifteen minutes; but afterward it was found that this rate was diminished at least twenty per cent. in the actual working on the stone in the tunnel, demonstrating that the enormous pressure had caused a compression that had not been anticipated, and was even then scarcely to be believed.

That the actual rate of rock drilling in any tunnel or other great engineering work would be at least 20% less than the rate shown in an experimental test is only what would naturally be expected, and it is not necessary to assume any phenomenal "compression" of the rock to account for it.

Another "Century" paper of much interest to engineers is an account of the work of the United States Weather Bureau, written by Mr. Gilbert H. Grosvenor, Editor of the National Geographic Magazine.

The "Review of Reviews" for June contains a well-written description of the Truckee-Carson irrigation system, where 50,000 acres of land will be supplied with water from works built by the U. S. Reclamation Service and formally opened to the public on June 17, the third anniversary of the passage of the Reclamation Act.

Of the short and well written articles on practical topics of current interest which the "World's Work" presents to its readers, the following in the June number deserves a word of mention here: "Does our Insurance Cost too Much?" by Sereno S. Pratt; "The Modern Profession of Inventing," by French Strother; "Foresting the Prairies," by Chas. M. Harger, and two articles on the street railway situation in Chicago, one of them written by Mayor Dunne.

"The Cause of South American Revolutions" is the subject of a short but very interesting paper in the June "Atlantic," by Geo. A. Chamberlain. He does not agree with most critics in ascribing the frequent revolutions to racial characteristics, but holds "that the instability of republics has been in the ratio of their social and economic centralization," In other words, so long as the Government of a country and all its social and commercial strength is centered about one city, revolt against established government is easy. Mr. Chamberlain continues as follows:

> The case thus diagnosed, the antidote is evident. Merely normal development along the channels that have made us in reality the United States of America; popular education, and free communication, more explicitly defined in the one word, "railroads."

In other words, the building of railways throughout South America will be the surest means of bringing good government and its blessings to that continent. In the same magazine there is an excellent summary of the current discussion upon Federal regulation of railway rates by Mr. Ray Morris, Editor of the Railroad Gazette.

In the "North American Review," Mr. H. C. Penfield writes on "Suez and Panama," and draws some interesting comparisons, particularly with reference to the probable volume of traffic at Panama. If any engineer imagines a continuous procession of vessels passing through the canal, such as that which sails up and down the St. Mary's River, it may be interesting to learn that the average traffic through the Suez Canal after 36 years of use, is only ten ships a day. That the Suez Canal is far more important to the world's sea-carrying trade than the Panama Canal is likely to be, is conceded by all competent authorities. Mr. Penfield estimates that a traffic of 7,500,000 tons may be reached at Panama or three-fourths the present traffic at Suez within six years after the canal is opened, but the tolls from that traffic will not be sufficient to make the canal directly profitable as a commercial enterprise.

MILITARY LANDSCAPE SKETCHING.—By M. Lefebvre. Translated from the "Journal des Sciences Militaires," for September-October, 1901, by Captain W. V. Judson, Corps of Engineers, U. S. Army, Instructor in Military Engineering, Engineer School of Application, 1902. Washington Barracks, D. C.: The Engineer School. Paper; 6 x 9 ins.; pp. 39; 33 figures in the text.

The author advocates landscape sketching not only as a needed complement to topographic drawing as an aid in military operations, but also as an educator of the eye, as teaching accuracy of observation, the appreciation of distance, etc. In speaking of photography, assumed by some as superseding the pencil sketch, it is pointed out that a photograph sufficiently good to give real information is a resultant of atmospheric conditions and position. In itself a photograph brutally exaggerates near objects and leaves the really important distance vague and indistinct. But, under favorable conditions, the photograph may be useful as a supplement to the trained hand sketch, which the author deems preferable.

The successive parts of this book take up in detail the methods to be pursued in military sketching; the representation of distance, form of the ground; lines and angles; prominent objects; forests, cultivated and wild land, etc. The subject is very well handled, and the treatise is useful to the sketcher from nature for any purpose, and it is especially valuable to the topographer.

COURSE OF WHOLESALE PRICES, 1890-1904.—Street Railway Employment in the U. S. Bulletin of the Bureau of Labor, No. 57, March, 1905. Issued every other month. Washington, D. C.: Pub. Doc. Paper; 6 x 9 ins.; pp. 389 to 720; many tables.

Most of this bulletin (161 pages) is devoted to a wide range of statistics of wholesale prices during the last 15 years. Many of the figures will interest and some should be of direct value to engineers and contractors. There are about a hundred pages on Street Railway Employment in the United States, most of which is in the form of text. This review is quite comprehensive, discussing number and geographical distribution of employees, conditions of admission to employment, health, discipline, rules, the merit system, wages, hours of labor, pensions, savings, organization or unions, arbitrations, accidents and present status of employees.

The many requests for directions for obtaining the paper on "Water Hammer," noted in our issue of May 18, indicate a marked interest in the subject and also a deficiency in the address given in the notice. It should have been stated that the Moscow named as the place of publication is Moscow, Russia. It may be added that the author is the daughter of Mr. Nicholas P. Simin, Chief Engineer of the Moscow Water-Works, and that the paper in question was reprinted from the Proceedings of the American Water-Works Association for 1904. (John M. Diven, Secretary, Charleston, S. C.)

Publications Received.

DIE DAMPFTURBINEN.—Mit einem Anhange über die Aussichten der Wärmekraftmaschinen und über die Gasturbine. By Dr. A. Stodola, Professor at the Federal Polytechnic School at Zurich. Third edition, greatly enlarged. Berlin: Julius Springer. Cloth; 7¼ x 11 ins.; pp. 454; folding plates, many text illustrations, and three lithograph tables. 20 marks; American price, $8.

GEOLOGIC ATLAS OF THE UNITED STATES.—U. S. Geological Survey, Charles D. Walcott, Director. Washington, D. C.: Pub. Doc. Stiff paper; 18 x 22 ins.

No. 117: Casselton-Fargo Folio. North Dakota-Minnesota. Pp. 7; colored maps, and 15 text figures.
No. 118: Greeneville Folio. Tennessee-North Carolina. Pp. 8; colored maps, and five figures.
No. 119: Fayetteville Folio. Arkansas-Missouri. Pp. 6; colored maps, and seven text figures.
No. 120: Silverton Folio. Colorado. Pp. 34; half tones, colored maps, and text figures.
No. 121: Waynesburg Folio. Pennsylvania. Pp. 12; plates, colored maps, and text illustrations.

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Both analytical and graphical methods have been employed for obtaining stresses, and the one which seemed best suited for any particular subject has been adopted. Few tables are given, as it was thought unnecessary to repeat information given in any of the rolling mill handbooks.

Although the book is written primarily for students and draftsmen, it will be found a valuable adjunct to the library of every practising bridge designer. Of especial interest are article 17, treating of the design of a knee-braced mill building, and article 20 which discusses the rivet spacing and web splices in plate girders, in which one-eighth of the web plate is counted on as flange area.

The Engineering News Publishing Co.
220 Broadway, New York

INTERNATIONAL SUGAR SITUATION.—Origin of the Sugar Problem and Its Present Aspects under the Brussels Convention. By Frank R. Rutter, Assistant Chief, Division of Foreign Markets. Bulletin No. 30, Bureau of Statistics, U. S. Department of Agriculture. John Hyde, Statistician. Washington, D. C.: Pub. Doc. Paper; 5¾ x 9 ins.; pp. 98; tables, four plates, and one text figure.

THE LAW RELATING TO OIL AND GAS.—Including Oil and Gas Leases and Contracts, Production of Oil and Gas, both Natural and Artificial, and Supplying Heat and Light thereby, whether by Private Corporations or Municipalities. By W. W. Thornton, Author of "Railroad Fences and Private Crossings," etc. Cincinnati, O.: The W. H. Anderson Co. Leather; 6 x 9½ ins.; pp. cxi + 918. $5.

MAP OF THE UNDERGROUND RAILWAY OF NEW YORK.—Showing Its Connection with the New York Central & Hudson River Railroad at Grand Central Station and at Other Points. New York: N. Y. C. & H. R. R. R. (Send 2-ct. stamp). 12-page folder, 9 x 4 ins.

NEW YORK STATE DEPARTMENT OF LABOR.—Report for the Twelve Months Ending Sept. 30, 1904. Albany, N. Y.: Pub. Docs. Cloth; 6 x 9 ins.

Eighteenth Annual Report on Factory Inspection. Pp. xxxviii + 1103.
Twenty-first Annual Report of the Bureau of Labor Statistics. Pp. 84 + 1041.
Third Annual Report of the Commissioner of Labor. Pp. 329; diagrams, charts, and 11 illustrations. Also, Seventeenth Annual Report of the Board of Mediation and Arbitration. Pp. 363.

NOTES ON BRITISH REFUSE DESTRUCTORS.—With an Introductory Comparison of British Refuse Destructors and American Garbage Furnaces. By M. N. Baker, Ph. B., C. E., Associate Editor of "Engineering News." New York: The Engineering News Publishing Co. Paper; 4½ x 7 ins.; pp. 60; three figures in the text. 25 cts.

RAILROAD COMMISSIONERS OF IOWA.—Report for the Year Ending June 30, 1904. Des Moines, Ia.: Pub. Doc. Cloth; 6 x 9 ins.; pp. 447.

RAILROAD COMMISSIONERS OF MASSACHUSETTS.—Report for 1904. Boston, Mass.: Pub. Doc. Cloth; 6 x 9 ins.; pp. lxxxiv + 697; tables, and two folding maps.

STANDARD METHODS OF WATER ANALYSIS.—Report of Committee to the Laboratory Section of the American Public Health Association. Presented at the Havana Meeting, January 9, 1905. Chicago, Ill.: Journal of Infectious Diseases. Paper; 6¾ x 9½ ins.; pp. 141.

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